CURRENT SCIENCE

Vol. XII] MAY 1943 [No. 5

STORAGE OF FOOD GRAINS

THE recent establishment of a separate department of food, with a budget of twenty crores of rupees, by the Central Government has been part of a vast network of developmental activities in India, as in other allied countries, inaugurated to meet the complex and emergency conditions created by the War. It bears ample testimony to the realisation of the tremendous importance of food supply in a country of such vastness, variety and distances as India. The large body of the defence personnel and the huge civilian population in the country, both together, demand an extremely wide and well-organised and efficient system of adequate food supply. At a time when war has come to the very doorsteps of the citizens, and when, practically, every one, from the office clerk to the munition factory worker, is engaged in war effort, and when high civilian morale is considered to be as important as the morale of the fighting forces, the question of an adequate supply and equitable distribution of food necessarily assumes infinite importance.

Nor is the matter of proper storage of food grains and other products meant for consumption any less important at a time like the present. Few people realise that the State and its citizens, as well as the fighting forces, have to contend with quite a vicous and powerful army of sabotaeurs, where preservation of food grains is concerned. It is estimated that the direct and indirect loss sustained every year in India in the sphere of staple food commodities before and after harvest on account of the destructive activities of a variety of insects alone, easily mounts up to two thousand crores of rupees; and a fair proportion of this loss has been attributed to the havoc played by that special group of insects that infest food grains and other related products in storage. While, in normal times, the very inadequate or even entire lack of appreciation of this colossal destruction of vital food materials by insects could, perhaps, be somewhat excusable; in times of war, any such tendency on the part, even of the individual citizen, and the State in particular, would be utterly suicidal.

Directly, the insects excavate and feed on or otherwise destroy the vital contents of the grains, besides filling their cavities and the store in general, with their fæces and the dead; indirectly, as a result of their normal and vital life-processes of

respiration and metabolism, the internal atmosphere of the storage receptacles, etc., is rendered so excessively humid and warm as to cause the growth of harmful fungi and the starting of fermentation; the grains, being themselves alive and, in a state of active respiration, further complicate and worsen matters. Where insect-infested grains remain in storage for long periods the cumulative effect is rarely less than total devastation; for, even that portion of the food grains that escape the direct attentions of the insect populations, is ultimately rendered unfit for human consumption, having been so badly affected by the evil effects of fermentation.

Man was faced with the problem of securing a proper storage of his food grains, the moment he thought of harvesting and conserving his crops. Various methods of storage have since been in vogue in different parts of the world with the common object of preserving the grains from the destructive activities of certain kinds of predatory insects and mites which thrive and breed in food grains during storage. A review of the methods of grain storage practised over considerably long periods reveals that they are too few and circumscribed in character. But some of the age-old methods, though very simple and somewhat crude, are really very ingenious and suggestive and serve the purpose for which they are applied fairly well. Of comparatively recent introduction are other methods that tend towards much complexity and specialisation, and lie rather beyond the scope of the average agriculturist, the grain merchant or the housewife, especially in India; but they may be easily adapted to the special and emergent conditions brought about by the war, through the agency of the Central and the Provincial Governments in the country.

It should be extremely interesting and instructive to examine critically the several methods of storage of food grains already in vogue in this country. Practically all these are age-old and time-honoured methods, having their good as well as bad points. And, having regard to the economic conditions of the peoples of India, they appear to be almost ideal; but, it should be admitted that they are so, not from the point of view of efficiency but the standpoint of easy adoption and management; the desirability or the possibility of improving upon them, therefore, does exist.

It is difficult within the limits of this note to go through all the several methods pointing out in detail their merits and demerits and considering ways and means of improvement. A few of the more important ones could, however, be touched upon briefly. The earthen pots, bins and baskets made of bamboo, plaited straw and fibre, gunny bags and underground cellars of different shapes and sizes, used as containers for storing grains—cereals and pulses—and other forms of food materials in rural and urban parts of the country are all fairly well known to everyone. These containers would not have been accepted generation after generation, if they had not their very good points about them. The very shape of the pots and bins—with narrow necks (mouths kept sealed up) and wide and oblong or spherical bodies, some of them with small valve-like lateral outlets, somewhere towards the bottom, is admirably well suited for the purpose of preventing serious damage by insects. The tightly-packed grains inside leave little or no room for movement or other activities of the insects. The practice in some localities of mixing the grains with extraneous matter like sand, husk or ashes, further helps in blocking up interspaces between the grains. Bags and sacks made of gunny, plaited straw and fibre, and with tightly-packed grains to the brim and stacked one on top of another, usually prove fairly efficient in keeping insect damage to a minimum, as the great pressure thus exerted on the pile of bags, effects a further and closer packing of the medium, thereby reducing the moving space for the insects. Cement concrete cellars, above or underground, rendered perfectly air-tight and dry, with a tight fitting and carefully operated trap-door, also serve to an appreciable extent to keep away most of the insect pests. The practice of smearing the top layer of grains (pulses) with castor oil, when baskets and bins are employed for storage, has the particular advantage of preventing the successful hatching of the grubs and later, boring into the grains; the presence of the oil renders the hold on the grains necessary for excavating impossible. One of the most interesting methods of control practised in certain rural areas and now apparently

given up, consisted in the use of a small pellet of mercury in a shallow cup placed in a corner of the storage receptacle on the topmost layer of the grain. Mercury is sometimes used for preserving certain kinds of pickles safe from "worms". One of the most common preliminary treatments of the grain before storage practised even by the less advanced of village folk is the sun-drying of the grains spread in a thin layer for varied lengths of time; this has been found to constitute one of the most natural, simple and efficient methods of rendering the grains sufficiently dry for storage and of ridding them of the associated insects that might have been carried over into the grain from the field, the threshing grounds or during transit.

This brief review of some of the existing methods leaves one to wonder why, in actual practice, so much of damage and loss is still being caused by insects during storage. The reason lies in the circumstance that necessary attention to detail is not paid in the practice and application of the methods. Often, the methods are not described in sufficient detail and with adequate precision to bring the method under scientific control. Efforts to eliminate these defects to a large extent are being made and a few improvements have been effectively introduced and successfully demonstrated. But the indifference and the conservative attitude on the part of the people expected to adopt these methods, has continued. This is well illustrated by the fact that the recommendation based on the discovery that a top dressing of the mass of grain under storage with a two-inch layer of sand effectively prevents infestation, has not been generally adopted in spite of its obvious simplicity and proven efficiency.

There is, however, considerable scope for further research in the direction of evolving other simple, inexpensive and effective methods and in improving upon the old ones. A few such lines of work may, perhaps, be touched upon at this stage. While the shape of the bins and baskets used for storage all over the country and the constructional materials from which they are made are undoubtedly ideal for Indian conditions, specially in rural parts, the mixture of mud and dung used to smear the outer surface urgently requires to be substituted by some equally porous but far less vulnerable material, exhibiting little tendency to crack or peal off with age. Bamboo and fibre bins, which are highly susceptible to termite attack should be rendered termite-proof. The usual practice of keeping the receptacles elevated on stone and other kinds of supports does not always leave them immune from the attentions of this dangerous pest. The bags or sacks made of jute, fibre and plaited straw generally have a large surface exposed and invite insect invaders; this circumstance offers the possibility of employing some inexpensive, efficient and innocuous insecticide in the form of fine dusts or sprays to cover the exposed portion of the bags at regular intervals. This treatment will serve to repel or kill the invading insects. In the case of cellars or pits full with grains, our knowledge is very meagre with regard to the environmental conditions prevailing there. The effect of these conditions on the quality of the grain has not been carefully determined. The nature and extent of infestation in them more than in other methods of storage, largely depend upon the factors of temperature and humidity. A critical study of the interplay of these two factors inside them, though extremely difficult to conduct is, nevertheless, essential if grains stored therein for long periods, have to be preserved from insect damage and in a perfectly fit condition for human consumption and for seed propagation. The reputed property of mercury in preventing insect infestation needs to be carefully and scientifically examined. A certain amount of work has been carried out in India in recent years in this connection but unfortunately it did not progress sufficiently far. Not only the pure metal but even tin amalgam was found to have a decidedly deleterious effect, particularly on the eggs of certain species of insects infesting grains. While the how and why and numerous other details of the peculiar influence of mercury on insect eggs would, undoubtedly, form most fascinating lines of study, the investigation of the practical utility of the method applied on a large scale, is one that could be taken up with advantage.

The more modern and specialised methods of controlling the grain pests, recently evolved by research, may now be considered at some length. The practice of subjecting infested grains and other food

products to the action of poisonous fumes is prevalent in other countries, particularly in the United States of America. The practice of fumigation on a large scale being a highly technical process, is naturally entrusted to qualified chemical engineers and others specially trained for the purpose. Where food grains and other products meant for consumption are concerned, the method assumes special importance and special precautions become necessary. The rates of respiration and metabolism of the infesting insects have a direct bearing on the efficiency of fumigation. Attention should be paid to the residual fumigant whose quantity is likely to vary with different kinds of food materials, and to the most effective method by which the residue can be successfully eliminated or neutralised. It is generally recognised that fumigation is only rarely resorted to for purposes of ridding food-stuffs of insect infection even in countries outside India, because of lack of adequate knowledge with respect to the food-worthiness of the grains fumigated by hydrogen cyanide and carbon disulphide. It has been established that an auxiliary fumigant like carbon dioxide enhances the effect of the principal fumigant like hydrogen cyanide by causing the insects to keep open their spiracles or breathing apertures; but no attempts appear to have been made to examine whether carbon dioxide does not concomitantly help in the absorption of larger amounts of the fumigant by the food grains themselves, in which case the problem of residual fumigants becomes much more serious. In the present uncertain and unsatisfactory state of our knowledge, it would appear safer to concur with the view that, in the task of preserving food grains, simple and safe methods alone are to be recommended and adopted until, at least, the most correct form of fumigation practice is evolved and established to be perfectly safe from the consumers' point of view.

Other substances like methyl-bromide and "Chlorosol" (a mixture of ethylene dichloride and carbon tetrachloride) for example, have, of late, been widely recommended as decidedly safer and equally effective. It is high time that competent authorities under the auspices of the Department of Food took up a comprehensive investigation of the practicability of the use of these and other types of "Safe" fumigants. Under the stress of the existing emergent conditions in India, the need for storing large quantities of food grains in a large number of localities all over the country, has definitely arisen; the time is, therefore, ripe for planning and implementing.

Processes like dry-heating and cold-storage have been employed in prevention of insect infestation of food-stuffs. These physical control measures also deserve to be considered very seriously, in so far as they are perfectly "safe" for the consumer. No expense can be too high in the matter of setting up and operating the necessary heating plants and cold stores, at a time like the present.

If the country should reap the fullest benefit from the creation of the Department of Food with its princely budget, the functions assigned to the Department should include the task of advising and guiding the large body of private people, the grain merchant and the individual citizen, in the matter of combating insect enemies effectively. This task can be performed only by technically trained men. The best course to adopt in this connection appears to be to employ sufficient numbers of such men to work under the several Regional Food Commissioners who have recently entered on their duties and have now been touring in different parts of the country. In addition, a Central Research Committee or several Regional Committees of Scientists, including entomologists, chemical engineers, biochemists and others, may be set up with a view to plan and investigate urgent aspects of problems of proper storage and treatment of food grains, with the help of a body of qualified scientific workers. Food supply in India at the present juncture is second to no other problem in importance and no effort should be spared to see that the populations are well and adequately fed.

CRUMB STRUCTURE AND SOIL FERTILITY

BY

V. A. TAMHANE AND A. SREENIVASAN

(Institute of Plant Industry, Indore)

ALL soil research aims, ultimately, at the production of larger and better crops for the better nutrition of our human and animal population. It is, therefore, natural that early efforts were directed towards assessing the fertility of soils through a study of their chemical composition and the availability of plant foods contained in them. The limitations of such methods were soon felt when it was experienced that soils having an adequate mineral content can yet be infertile and that soils apparently similar in regard to their chemical composition and mechanical analysis can show wide differences in yielding capacity. It was then that the importance of air and water for crop growth was adequately realised. Great strides have since been made in our knowledge concerning the physical properties of the colloidal material in the soil. But we have not, as yet, evolved a satisfactory method for giving quantitative characterization to the physical condition of the soil, especially in its natural field state. It may, nevertheless, be stated that so many aspects of soil physics, particularly those having a bearing on some relation between soil air and soil water, are intimately connected with the field structure of soils that studies on the degree of aggregation and the stability of aggregates have contributed largely to a fuller understanding of the processes controlling soil fertility. This emphasis on the structure of soils as a vital factor in their evolution or degradation is, undoubtedly, a great improvement on the older view which merely stated that the soil was deficient in this or that nutrient and that something must be done to restore its level or maintain its supply.

Structure Defined

Structure is a term expressing the arrangement of the individual grains and aggregates that make up the soil mass. The individual grains are the mechanical or textural separates such as sand, silt and clay and are, therefore, the primary soil particles while the aggregates consist of an intimate grouping of a number of primary particles into a secondary unit. The structure of any particular horizon of a soil profile as it appears to the eye of the soil morphologist may be considered as the *macro*-structure of the soil in this layer and refers to the natural arrangement of the soil when in place and undisturbed. Based on the size, shape and character of the faces and edges of these aggregates, terms such as 'nutty', 'mealy' 'granular', 'prismatic', 'columnar', 'platy', 'honey-comb', etc., are used to distinguish between the principal types of field structure[1-3]. Another classification of structure takes into account the structural arrangement of the primary and secondary particles, both in themselves and in a mixture of the two[4]. Several other structural groupings have been suggested such as those based on the type of pore space and the nature of the binding material that is responsible for aggregate formation[5-7]. Agriculturally, however, the kind of structure that is important in its effects, both direct and indirect, upon the soil as a plant habitat is the degree of aggregate formation which resists, under ordinary conditions, the dispersing action of water or beating rain. Aggregation of soil particles into crumbs or granules is the only structure having any practical value and the only one the formation of which has been studied in any detail.

Tilth of Soils

By tilth, we understand, ordinarily, the pulverulent condition of the soil which results from successful tillage. A good tilth is a condition which the farmer tries to produce and maintain, when produced, so that it is most suited to the growth of plants. This condition can be recognized in the field by an experienced farmer. Unfortunately, there is, as yet, no single method by which it can be measured quantitatively, for it is the result of many factors which have not been isolated and analysed, but one of the fundamental factors is undoubtedly a good crumb structure. Tilth is closely related to this structure or aggregate formation since both are associated with the presence of

colloidal material. Soils devoid of colloids have what is known as single-grain structure, each grain acting as a unit and no compound particles being present. Because of the size of the grains, the tilth of sandy soils is seldom bad. They are well drained, but of course lack the capacity to store moisture or retain plant foods, especially in tropical tracts. Soils containing varying amounts of colloids, on the other hand, present a rather serious problem. The individual grains are so small that if they are forced into a position of close packing, either by mechanical pressure or by the beating action of rain, they become exceedingly hard and impermeable to both air and water. Hence, soils containing appreciable amounts of colloids and with single-grain structure, are the most difficult to manage. Soil husbandry should, therefore, aim at the building up of stable aggregates or crumbs from these single grains.

Structure and Air-Water Relations

For healthy plant growth, the plants must have a continuous supply of soil moisture which does not reach the two extremes of drought and waterlogging. For this condition, two properties of the soil are of great importance: (*a*) the ease with which excess of water can drain away from a soil under gravity, and (*b*) the amount of water the soil can hold against gravity. These needs are satisfied by the soil having a suitable distribution of pores[8]. If all the pores are large, as in coarse sand, water will drain away freely and air will have easy access to all parts, but if the pores are small, as in silt or unflocculated clays, water will be held in them against gravity and air will enter with great difficulty and the plant will die of asphyxiation. The ideal soil has such a pore size distribution that there are sufficient large pores or *macro*-pores for adequate gaseous exchange to take place between the soil air and the atmosphere and sufficient small pores or *micro*-pores for the soil to hold a reasonable amount of water against drainage for the utilization of plants[9]. This ideal condition of the soil is in part dependent upon the size and arrangement of the soil particles and is mainly controlled by crumb or aggregate structure. In an aggregated soil, the pore space is discontinuous, for the fine pores inside the individual aggregates are usually much finer than those between the aggregates. These pockets of fine pores inside each aggregate act as water reservoirs surrounded by large channels down which surplus water can drain away and so facilitate gaseous exchange between the soil air and the atmosphere.

Flocculation *vs.* Aggregation

Since structure is associated with the colloidal fraction of the soil and since compound particle formation of colloidal materials is usually referred to as flocculation, early students have attempted to approach the problem of soil structure or formation of soil granules by a study of the flocculation of clay soils. While, however, there are instances where mere flocculation of puddled soils have been followed by increased productivity, there is a vast difference between flocculation from the purely colloidal point of view and aggregation from the standpoint of structure. Chiefly, a floccule is stable only as long as the flocculating agent is present whereas stable aggregates are held together by a cementation of the flocculated particles. It is possible that flocculation is an essential first step in the granulation process but there is no doubt that granulation is much more than flocculation, involving as it does a combination of different factors.

Hypothesis of Crumb Formation

The mechanism of the formation of the soil aggregates is one of the most important but hitherto least understood phases of the soil structure problem. The cause of granulation has been variously attributed to the water film, the exchangeable cations, the organic matter, the inorganic colloids of the soil, as also the natural processes of heating and wetting[10]. But, it would appear that the cementation of clay particles at low moisture contents is probably the most important mechanism enabling mineral soils to form crumbs[11].

Crumb and Clod Structure

The difference between the crumb structure and clod structure of a soil is not yet understood, nor has it yet been possible to distinguish them on purely quantitative grounds. It has been assumed that clod structure is produced by purely mechanical means such as cultivation and can be altered at will by such means whereas crumb structure is an inherent property of the soil displayed when conditions are suitable[12].

By ploughing and cultivating a clay soil when wet, huge clods can easily be produced. If these clods are now subjected to a hard frost after the thaw, the clods will have fallen down to small, very stable crumbs so that the land will have lost its clod structure and gained a crumb structure through the agency of the frost[13]. If, on the other hand, these wet clods are dried, they will form hard lumps very resistant to cultivation. So far, the distinction between clod and crumb structure is clear. But if these clods are rewetted under suitable conditions and then carefully cultivated, they will fall down to smaller aggregates and, by continued suitable wetting, drying and cultivation, aggregates of any size can be produced. These aggregates can only be formed by the agency of wetting and drying, cultivation merely hastening the breakdown into suitable aggregates. Again, if the soil were originally ploughed under appropriate conditions, it would break into quite definite aggregates as it was turned in the furrow. This example shows that it is rather difficult to distinguish strictly between crumbs and clods.

The Stability of Structure

Crumbs may have two types of instability: (1) mechanically weak, and (2) unstable in water. If the soil clod does not contain sufficient colloidal material, the crumbs or clods formed in the soil will be mechanically weak and break down very easily to dust by cultivation operations, by the erosive action of the wind or by mechanical shattering through the action of falling rain drops. The last effect is well illustrated by the capping which heavy rain causes on some types of soils. Water-instability of crumbs is in part due to physico-chemical causes. Thus, if the clay forming the crumbs contains much replaceable sodium, the crumbs will be mechanically strong when dry, but will disintegrate when wetted with water, due to the weakening of the cohesion between the individual clay particles forming the crumb. This type of instability often occurs in arid regions, particularly when subjected to irrigation and has caused grave agricultural damage to large tracts of irrigated land.

The water-stability of the aggregates is of the utmost importance in promoting and preserving good structural conditions in the soil. Water may cause a breakdown or deterioration of the aggregates through the process of swelling and 'exploding' of the entrapped air (referred to later), or by mechanical action as with beating rain. The impact of falling rain will have a dispersing action on the aggregation of an exposed soil. These dispersed particles will then be carried into the soil pores causing compaction.

Aggregate Analysis

Aggregate analysis of the soil measures the relative distribution of the various sizes of aggregates and permits a calculation of the percentage aggregation of the finer mechanical separates. Such an expression is really an index of structure though, of course, it does not characterize the type of structure. A large number of methods of aggregate analysis have been proposed and used. In general, three techniques are employed to accomplish such an analysis. They are: wet and dry sieving, elutriation and sedimentation. Russell and Tamhane[12] have recently reviewed the different methods and their limitations. According to them, the aggregate analysis of the soil should be carried out under two conditions of wetting: (1) a slow wetting of the air-dry soil, when the minimum break-up of the larger aggregates takes place and which may represent the inherent water-stable aggregation of the soil, and (2) a rapid wetting of the air-dry soil, which causes a maximum break-up of the larger aggregates and may give the absolute water-stable aggregates. It would, however, appear essential that for obtaining a true picture of the structural capacity of field soils, the samples should not be completely dried or stored for long before making an aggregate analysis.

In the expression of results, the percentage of aggregates greater than 0·05 mm. in diameter has been used to characterize the "state of aggregation" of the soil[14, 15]. This lower limit has been chosen on the basis of the fact that the curves for the aggregate and mechanical analyses intercept near this point, which makes it possible to determine aggregates smaller than 0·05 mm. from the two curves[16,17].

Processes Contributing to Crumb Structure

Inasmuch as the properties of the soil as regards moisture, aeration and heat and, especially, permeability, water capacity and the degree of water penetrability are all

greatly dependent upon a good crumb structure, one of the primary functions of soil husbandry will be to create and maintain, when created, a good soil tilth. Two soil properties are important in this connection: (1) the ease with which a soil will form crumbs, and (2) the stability of the crumb structure when formed. Very little is known about the factors responsible for the ease of crumb formation in the soil though, admittedly, soil-forming climatic factors play an important part. Aggregate analysis of a large number of different soils are available which have yielded significant data for a correlation between climate and aggregation[18].

Organic Matter.—Foremost among the other factors contributing to aggregation comes organic matter. It is common knowledge that organic matter serves to aid aggregation in soils. The method of pretreatment with hydrogen peroxide before dispersing soils for mechanical analysis serves to get over the cementing action of organic matter. The exact mechanism of this cementing action of organic matter is little understood. The majority of evidence would appear to point to a kind of adsorption of the humus by the inorganic soil colloids, this adsorption being accompanied by a dehydration which brings about a stable union between the inorganic and organic materials[19-21].

It is not the organic matter itself so much as its decomposition that is important in structure formation[22]. The more rapid the decomposition, the better is the structure[10]. Decomposition of cellulosic materials, such as that resulting from the incorporation of straw into the soil, is especially attended by a marked improvement in structure even though the process of decomposition is very slow. Autolytic products, synthesized by micro-organisms, have a strong cementing action on the soil colloids. It has been suggested that mucus may be the most effective cementing agent[23, 24].

The fertility of humus-rich soils is well known. Indeed, humus is the thing which "makes all the difference between the soil and a mere geological deposit"[25]. It is generally held that every soil, depending on a number of completely interlocked factors, mostly climatic, has more or less definite organic matter level and that, therefore, it is hardly worthwhile to attempt a maintenance of the soil organic matter above certain percentages[26-31]. Recent evidence at Indore would point out, however, that it is possible, by continuous application of bulky organic manures over a period of some years, to raise appreciably the organic matter status of soils as compared to untreated plots; such treated plots are also very high-yielding and possess distinctly better crumb structure[32]. It is, therefore, desirable to carry out tests, under a variety of conditions, whether organic matter content of soils can be built up consistently with economic attainment of high yields.

Crop Effects.—With regard to structure in relation to the growing crops, Russian scientists have studied in considerable detail the effect of different crops on the deterioration and regeneration of soil aggregation[19, 33-35]. Of especial significance has been the result of the relations of grassland systems to soil structure; stable structure is best achieved by temporary ley or grass vegetation[33, 36, 37]. The use of elephant grass in this connection has been described by many workers and found to be of value under East African conditions[38-40]. The dawning recognition of the importance of grass in maintaining a high level of fertility in humid regions is paralleled in semi-arid regions by the recognition of its value in preventing erosion both by affording a dense vegetation cover and by providing a structure which resists erosion when the land is subsequently ploughed. Here, in India, ley farming has not gained any recognition in spite of its importance both in soil rejuvenation and from the point of view of fodder production.

Apart from the particular effect of grassland on soil structure, the mechanism of which is as yet not well understood, all growing crops can affect the structure of soil both indirectly and directly. The indirect effects result from the changes in granulation caused by the increased organic matter produced by plant growth. The direct effects are: "canopy" protection[41] and root influences. The first of these relates to the protection afforded by the leaves and stems against the impact of rain drops by preventing dispersion of the soil. This influence is obviously more effective the denser the foliage and the more rapid the rate at which the protective cover is established. With regard to the influences of root activity on soil structure, we cannot as yet distinguish between the aggregation effects of root pressure referred to later and the binding qualities of root hairs, the produc-

tion of organic matter, moisture changes resulting from water absorption by the roots, or any possible root excretions. It is quite possible that all these factors operate together in developing granulation and porosity through root influences.

Alternate Wetting and Drying.—Next to organic matter and, from the point of view of natural agencies, even more important in influencing aggregation in soils, is the effect of alternate drying and wetting. Experiments have shown that drying or dehydration of the soil colloids causes a shrinkage of the soil mass and a cementation of clay particles. This dehydration cannot obviously be uniform as unequal strains will arise tending thereby to form clods. When these clods, formed as a result of drying, are wetted slowly, there is a rapid imbibition of water causing unequal swelling throughout the clod and producing thereby fracturation and fragmentation along the cleavage planes[42]. Another, but less well recognized process that follows the sorption of water into the capillaries, results in a compression of the air spaces and, finally, in a "virtual explosion within the clod" as the pressure of the occluded air exceeds the cohesion of the particles[43, 44]. The unequal strain and stress set up by the shrinkage and swelling together with the disruptive action, on wetting, of air entrapped in the pores cause a granulating action on the soil colloids.

Alternate swelling and shrinkage of the soil colloids are also likely to result from pressure effects such as those following the penetration of crop roots or burrowing animals into soil[45, 46]. Due to this pressure, the cementing influences of the water films are probably rendered more effective and the colloidal particles themselves are brought into more intimate contact with each other. The result is, in a soil of good structure, channels left by decaying roots or made by burrowing animals will not collapse but will remain to act as ventilating shafts.

Russian work[47-49] has shown that stable artificial structures can be induced in powdered chernozems and solonchaks by subjecting the soils to mechanical pressure at definite moisture contents depending on the soil properties. The possibility of devising cultivation implements which will perform in the field the mechanical operations which have been shown to produce stable structures in the laboratory requires yet to be explored fully.

It is not, however, always that pressure effects are favourable for structural development. For instance, we know that trampling or excessive cultivation operations, especially on a moist soil, is followed by a deterioration in structure. No quantitative information on the optimum moisture content of soils when pressure effects are most favourable is available and our knowledge of the exact manner in which pressure acts on structure formation is, therefore, difficult to evaluate.

Effects of Cultivation and Tillage.—Culturally, aggregation may be affected in a variety of ways. It is well known that cultivated soils are less granular than the corresponding virgin areas[50]. Tillage affects structure as a result of decreased organic matter production, increased organic matter decomposition, increased leaching, the impact of rain drops on the exposed soil and the mechanical manipulation of tillage implements.

When new land is broken for cultivation, great care is needed to work the soil at proper moisture content. Empirically, the farmer knows that the simplest test in order to determine if the land is fit to plough is to collect some soil just below half the depth at which the plough will work. If it is somewhat difficult to work the soil into a ball in the hand, and, on crushing, the ball breaks into several pieces, conditions are ideal. It is, however, an observed fact that a perfect structure, similar to that of the undisturbed virgin land, cannot be obtained though a structure sufficiently good to meet the demands of a high-yielding crop can usually be maintained.

The importance of working a land at the correct moisture content will be obvious when it is realised that a land badly tilled can show evidence of both waterlogging and drought at the same time. Tillage operations may have varied effects upon soil structure depending upon the nature of the implement and the moisture content at manipulation[10].

Modern science has shown that cultivation operations have only a minor influence on the moisture regime of the soil[51]. In consequence, much of the traditional views on this subject have to be abandoned or recast. At Indore, experiments on shallow *vs.* deep interculture carried out over a number of years have shown that shallow interculture just sufficient to keep down the worst weeds has yielded best and that the adverse effects of excessive interculture are due to

loss in structure resulting from constant trampling over the soil.[52] It has been shown, similarly, that preparatory cultivation on the black soils of India[53, 54] and in the Sudan[55] is superfluous and may, at times, be decidedly harmful[56]. Even in temperate and cooler regions, the effect of the traditional thorough cultivation has begun to be doubted[57].

Cation Effects.—Much work has been done on the dispersing action of different cations on the soil colloids. Of practical importance are the effects due to sodium and calcium. The poor structural qualities of alkali soils have been demonstrated more or less conclusively as due to a high concentration of sodium in the exchange complex of the soil. It is equally well recognized that soils in poor physical condition can be restored to good tilth if the sodium ion is replaced by calcium ion. These facts along with laboratory observations that clay suspensions can be flocculated by calcium salts, have led to the widely accepted view-point that the beneficial effects of lime are due to its ability to flocculate the soil colloids. But experimental evidence upon the effect of calcium ion on the physical properties of the inorganic soil colloidal fraction does not altogether support the view that calcium favours aggregate formation. Thus, it has been found that granulation is not correlated with the degree of saturation of the soil with calcium and that the calcium ion is in no way better than the hydrogen ion[58, 4]. It has even been reported that the hydrogen system is more favourable to granulation than the calcium system[59] and that lime has a dispersing action on soil aggregates[60]. Recent researches would appear to point out that the effect of calcium upon aggregate formation is only indirect through its promoting micro-biological activity and consequent increased production of humus[61-63, 21].

The cementing materials in some soils may be iron hydroxide[64] but nothing is known with precision. This is especially true in lateritic soils that are known both for their high degree of aggregation and for their large iron content[65]. It is also possible that colloidal alumina may play a rôle similar to that of iron in aiding aggregation and in affecting, generally, the physical behaviour of soils.

Effects of Manures and Fertilizers.—The beneficial effects of manures upon granulation and aeration have been dealt with before; little is known concerning the effects of fertilizers. Continuous use of artificial fertilizers over a period of years has been known to result in a marked degradation in soil structure[66]. It has been experienced that superphosphate application in eroded fields aids in the improvement of structure; it is as yet difficult to conclude whether this effect is only due to the gypsum component of this fertilizer[67]. It is essential to recognize in this connection the complex relationships that are involved upon manure applications to the soil and the rather varied results obtained by different workers relative to the effects of manures on soil structure[33, 34, 68, 69]. Indirectly, however, all fertilizers will, as with manures and lime, have a large influence in the preservation of structure through increased foliage and root production.

Effects of Drainage, Waterlogging and Irrigation.—Proper drainage is followed by increased aeration, greater root development, more intense bacterial activity and the promotion of oxidation processes. The combined effects of these factors will normally lead to better granulation while their absence will be accompanied by deterioration in structure.

The breakdown of aggregation in the surface during irrigation leads to crust formation which produces unfavourable air and water relations for plant-growth[33]. Hence, the effect of irrigation water, especially in arid regions, on the structure of the surface soil is similar to that of natural rain in humid regions unless, of course, water-stable aggregates are present in the surface layers. In addition, irrigation waters containing unfavourable concentrations of soluble salts will have their deleterious effects on structure[70].

Importance of Structure for High Yields

From the foregoing, it is perhaps reasonable to expect that aggregate analysis may well become, in the near future, a soil characteristic of considerable importance. The agricultural significance of structure lies in its promoting (1) the capacity to absorb and retain moisture, (2) resistance to erosion, (3) free drainage and absence of waterlogging, and (4) easy workability. A combination of these factors will normally lead to greater productivity so long as plant food is adequate. On the contrary, common observations have often revealed that soils apparently rich in fertility elements have

not always been highly productive. At Indore, the positive effect of a manurial or a cultural treatment observed in one experiment on a particular field has very frequently been negatived in the same season on another[71]. It soon became apparent that the difference was mainly due to the existence, in reality, of two different types of fields, one well drained and the other, eroded and waterlogged. The average yields of seed cotton for the two types of fields over a period of years were approximately 414 lbs. and 194 lbs. per acre respectively. The results of manurial trials during different seasons have shown that, with few exceptions, both artificial nitrogenous fertilizers and organic manures produce a good response on the well-drained fields and a very much smaller or no response from poor fields[72]. This, at first sight, appeared contrary to the general expectation that poor soils should be more responsive to manuring than rich ones. When closely examined, however, these results showed that poor fields were often characterized not so much by a deficiency of essential nutrients as by a loss in structure resulting from impeded drainage and waterlogging.

Another interesting and characteristic difference exhibited between well-drained and badly drained or eroded fields has been in respect of the nature and extent of their surface cracking during summer fallow. It has been possible to make a quantitative measure of the amount of cracking in different fields. The results have shown that cracking is deeper and more extensive in a good field as compared to an infertile field[73].

These results only emphasize the importance of restoring structural conditions of the surface soil before crop yields can be enhanced by suitable manurial applications. Soil conservation depends essentially on the amount, kind and stability of the soil aggregates and the problem of improvement of eroded land for successful crop-growth resolves, therefore, into one of restoring structure[74]. Some preliminary results have shown that, for the black cotton soil. an economic way of achieving this will be by keeping the sub-surface soil in a poor field open by dressings of lightly fired soil; not only increased yields are obtained without manuring, but response to manures is also greater on soils so treated[75].

To sum up, plants require, in addition to nutrients, air and water for growth. In the absence of adequate amounts of moisture, plants cannot utilize soil nutrients and carry on their normal physiological functions. The growth of plant roots and the germination of seeds require favourable air conditions for respiration. Moreover, a small root system restricts the soil volume in which nutrients are available for the plant. Lack of sufficient air and water also affects bacterial activity and the very necessary aerobic biological processes are greatly hindered.

The air-water relations of the soil are dependent upon structure. While a good deal of work has hitherto been achieved on the relation of soil nutrients to crop-growth, only inadequate attention has been given to providing a favourable soil-air-water environment to the germinating seed and the growing crop. Recent developments in soil structure problems have made it possible to define more or less precisely what was only vaguely recognized hitherto as tilth. Future work should aim at fully utilizing this knowledge gained in regard to the significance of soil structure for maintaining or restoring soil fertility.

---

1. Zakharov, S. A., *Russ. Pedol. Investgns., Acad. Sci., Leningrad*, 1927, **2**, 47. 2. Russel, J. C., Olmstead, L. B., and Hendrickson, B. H., *Amer. Soil Survey Assocn. Bull.*, 1929, **9**, 120. 3. Sideri, D. I., *Soil Sci.*, 1938, **46**, 337. 4. Baver, L. D., *Amer. Soil Survey Assocn. Bull.*, 1935, **16**, 55. 5. Pigulevsky, M. C., *Proc. II Int. Congr. Soil Sci.* (Leningrad), 1932, **1**, 82. 6. Kubiena, W. L., *Micropedology*, 1938, 134, Collegiate Press, Ames, Iowa. 7. Redlich, G. C., *Soil Sci.*, 1940, **50**, 3. 8. Russell, E. W., *Sci. Progress*, 1938, **32**, 660. 9. Doyarenko, A. G., *Jour. Agric. Sci.* (Russian), 1924, **1**, 451. 10. Russell, E. W., *Imp. Bur. Soil Sci. Tech. Comm.*, 1938, **37**. 11. —, *Phil. Trans.*, 1934, **233A**, 361. 12. Russell, E. W., and Tamhane, R. V., *Jour. Agric. Sci.*, 1940, **30**, 210. 13. Jung, E., *Kolloidchem. Beih.*, 1931, **32**, 320. 14. Middleton, H. E., *U. S. Dept. Agric. Tech. Bull.*, 1930, **178**. 15. Baver, L. D., and Rhoades, H. F., *Jour. Amer. Soc. Agron.*, 1932, **24**, 920. 16. Pavlov, G. I., *Proc. Second Int. Cong. Soil Sci.* (Moscow), 1932, **1**, 179. 17. Tiulin, A. F., *Trans. Soviet Sect. Int. Soc. Soil Sci.*, 1936, **5**, 28. 18. Baver, L. D., *Amer. Soil Survey Assoc. Bull.*, 1934, **15**, 107. 19. Williams, W. R., *Pedology*, 1935, Nos. **5** and **6**, 755. 20. Sideri, D. I., *Soil Sci.*, 1936, **42**, 461. 21. Myers, H. E., *Ibid.*, 1937, **44**, 331. 22. Geltzer, F. Y., *Trans. Soviet Section Int. Soc. Soil Sci.*, 1936, **5**, 115. 23. Martin, J. P., and Waksman, S. A., *Soil Sci.*, 1940, **50**, 29. 24. Myers, H. E., and McCalla, T. M., *Ibid.*, 1941, **51**, 189. 25. Jacks, G. V., *Jour. Royal Soc. Arts*, 1941, Lecture : Feb. 12th. 26. Russel, J. C., *Jour. Amer. Soc. Agron.*, 1927, **19**, 380. 27. Jenny, H., *Ibid.*, 1928, **20**, 900. 28. —, *Soil Sci.*, 1930, **29**, 193. 29. —, *Missouri Agric. Expt. Sta. Res. Bull.*, 1930, **152**. 30. Sahasrabuddhe, D. L., *Proc. National Inst. Sci.*,

1937, 3, 139. 31. Mohr, E. C. J., Cited from S. A. Waksman's *Humus*, 2nd. Edn., 1938, Bailliere, Tindall and Cox, London, p. 258. **32.** *Annual Reports, Institute of Plant Industry, Indore*, 1942. **33.** Sokolovsky, A. N., *Trans. 1st Com. Int. Soc. Soil Sci., Soviet Sect.* (Moscow), **1933, A1, 34. 34.** Ilmenjew, S. I., *Chem. Soc. Agr.*, 1935, (Russian), No. **6, 84. 35.** Heltzer, F. J., *Trans. 1st Com. Int. Soc. Soil. Sci., Soviet Section* (Moscow), **1934, A2, 73. 36.** Rostovzeva, O. S., and Avaeva, M. I., *Pedology*, 1935, Nos. **5** and **6, 797. 37.** Bradfield, R., *Jour. Amer. Soc. Agron.*, 1937, **29,** 85. **38** Nye, G. W., *East Afr. Agric. Jour.*, 1937, **3, 186**; 1939, **5, 460. 39.** Milne, G., *Ibid.*, 1938, **3,** 380; 1940, **5,** 204. **40.** *Report and Procs., III Congr. on Cotton Growing Problems*, Empire Cotton Growing Corporation, 1938. **41.** Wollny, E., Cited from L. D. Baver's *Soil Physics*, 1940, New York, John Wiley and Sons, Inc. **42.** Haines, W. B., *Jour. Agric. Sci.*, 1923, **13,** 296 **43.** Yoder, R. E., *Jour. Amer. Soc. Agron.*, 1936, **28,** 337. **44.** Henin, S., *Ann. Agron.*, 1936, **6,** 455. **45.** Gelroiz, K. K., Cited from (1). **46.** Tiulin, A. F., *Trans. I Com. Int. Soc. Soil Sci., Soviet Section* (Moscow), 1933, **A1,** 110. **47.** Vilenski, D. G., and Germanova, V. N., *Pedology*, 1934, **34**; 1937, 1361. **48.** Koposov, I. P., *Ibid.*, 1937, 184. **49.** Gorkova, I. M., *Ibid.*, 1937, 222. **50.** Jenny, Hans, *Missouri Agric. Exp. Sta.*, 1933, *Bull.* **324. 51.** Keen, B. A., *Endeavour*, 1942, **1, 52.** 52. *Annual Reports, Institute of Plant Industry, Indore*, 1935. **53.** *Ibid.*, 1937. **54.** Ayyar, V. R., Ayyar, S. S., and Tirumalachari, N. C., *Madras Agric. Jour.*, 1940, **28, 69. 55.** *Annual Report, Gezira Agric. Res. Serv., Sudan Govt.*, 1937. **56.** Viswa Nath, B., *Agric. and Live-stock in India*, 1938, **8,** 9. **57.** Russell, E. W., and Keen, B. A., *Jour. Agric. Sci.*, 1938, **28, 212**; Keen, B. A., *Jour. Min. Agric.*, 1938, **45,** 645. **58.** Baver, L. D., *Missouri Agric. Expt. Station*, 1929, *Res. Bull.* **129. 59.** Lutz, J. F., *Ibid.*, 1934, *Bull.* **212**; *Amer. Soil Survey Assocn. Bull.*, **17,** 24. **60.** Peele, T. C., *Proc. Soil Sci. Soc.*, America, 1937, **2,** 79. **61.** Baver, L. D., *Amer. Soil Survey Assocn. Bull.*, 1936, **17,** 28. **62.** Bradfield, R., *Ibid., Bull.*, 1936, **17,** 31. **63.** Geltzer, F. Y., *Chem. Soc. Agron.*, 1936, No. **8. 64.** Lutz, J. F., *Proc. Soil Sci. Soc.*, America, 1936, **1,** 43. **65.** Roberts, R. C., *Amer. Soil Survey Assocn. Bull.*, 1933, **14,** 88. **66.** Bargevin, H., and Henin, S., *Ann. Agron.*, 1939, **9,** 771. **67.** *Annual Reports, Institute of Plant Industry, Indore*, 1938, 1939. **68.** Musgrave, G. W., and Norton, R. A., *U. S. Dept. Agric. Tech. Bull.*, 1937, **558. 69.** Bertramson, B. R., and Rhoades, H. F., *Proc. Soil Sci. Soc.*, America, 1938, **3,** 32. **70.** Taylor, E. M., *Annual Report, Irrigation Research Institute, Punjab*, 1938, p. 131. **71.** Sreenivasan, A., *II Conf. Sci. Res. Workers on Cotton in India*, Indian Central Cotton Committee, 1941. **72.** *Report on the Results of Cotton Manurial Trials in India*, Indian Central Cotton Committee, 1942. **73.** Sreenivasan, A., *Nature*, 1942, **150, 409. 74.** —, *Ibid.*, 1941, **148,** 144. **75.** —, *Indian Farming*, 1941, **2,** 530; Sreenivasan, A., and Aurangabadkar, R. K., *Soil Sci.*, 1940, **50,** 449.

SOME POST-WAR PROBLEMS OF JUTE

BY

K. C. BASAK

(Assistant Economics Officer, Indian Central Jute Committee)

CONSUMPTION of jute has been considerably reduced owing to the war. Although jute is an important raw material for the war, its use for war purposes has not been sufficiently large to offset the fall in civilian consumption. This may be seen from the following table:—

World Consumption of Jute

(Lakhs of bales of 400 lbs.)

Season July—June	Consumption
1936–37	126
1937–38	113
1938–39	110
1939–40	113
1940–41	79
1941–42	88

In the third year of the war, the total consumption of jute fell by about a quarter of the pre-war consumption. The reduction in civilian consumption must have been much greater than this. Though no precise estimate of it is possible for want of relevant information, a few facts are noted in this connection.

Exports of raw jute and jute goods to the enemy and enemy-occupied countries, which in peace-time accounted for about 30 per cent. of the total world demand, have been completely stopped. In 1941-42, about 11 lakhs of bales of jute were consumed in India for war purposes. In the United States the civilian consumption of new jute bags has been reduced to half that of 1941, while the Government there is building up a large stock pile of raw jute and burlap from the available supply in the country. If the jute requirements for war purposes of the other Allied countries are also taken into consideration, it may not be wide off the mark to say that the total civilian consumption of jute (excluding secondhand products) is at present about half the pre-war consumption.

Thus the main problem of jute in the post-war period will be to increase its consumption to double the present rate of civilian consumption. The solution of this problem is dependent on a number of factors, some of which will be discussed below.

Transport

The reduction in the civilian consumption of jute has been brought about not by a fall in the actual demand for jute but because the demand cannot be made effective on account of transport difficulties. The civilian demand for jute in the Allied and neutral countries continues to be large and keen. But the demand can only be partially met because of insufficient shipping space available for exports of raw jute and jute goods from India. The cessation of hostilities will remove this difficulty, and the flow of raw jute and jute goods to countries overseas may be expected to resume its normal course. It may well be that with the progress of the war, easier conditions will prevail with regard to the shipping position, which may have a favourable effect on the jute trade. But many things may hamper the fulfilment of this expectation.

Markets

No other country in the world has got the natural advantages necessary for growing jute in large quantities. India, therefore, grows jute for the whole world. In times of peace about 85 per cent. of the total demand for jute, either as raw material or as manufactured goods, comes from abroad. The war has considerably restricted the market for jute. The following table shows the distribution of the demand for jute and the changes brought about by the war:—

World Demand for Indian Jute and Jute Goods

Countries	Average of 1936–37 to 1938–39 (April–March)		1941–42 (December–November)	
	Lakhs of bales	% of total	Lakhs of bales	% of total
Allied and Neutral (excluding India)	62·9	54·0	53·8	65·0
Enemy and Enemy-occupied	35·5	30·5	—	—
India	18·0	15·5	29·0	35·0
TOTAL ..	116·4	100·0	82·8	100·0

It appears from the above table—

(1) that the reduced consumption in the Allied and neutral countries has been more than offset by the increased consumption in India; and

(2) that the reduction in the consumption of jute equals on balance the loss of market in the enemy and enemy-occupied countries.

With the ending of the war, it may be expected

(1) that war-time restrictions will be removed and a major part of the markets, which is now cut off, whether in the enemy and enemy-occupied countries or in the Allied and neutral countries, will again be available for exports from India; and

(2) that the Indian consumption will be reduced to the peace-time level.

But things may not turn out to be as smooth as this. Jute substitutes, which are being grown in different parts of the world under the stress of the war, may hamper the complete restoration of the jute trade to its pre-war level. The opening up of new markets and the extension and development of the existing markets may become a matter of great importance for the post-war rehabilitation of the jute trade. The first step in this respect is to explore the potentialities of the Indian market for absorbing jute goods. It is with this end in view that the Indian Central Jute Committee has recently started an investigation of the Indian market for jute goods.

Substitutes

The next important step in this direction is a study of the economics and technology of the substitutes particularly with two objectives, *viz.*,

(1) to assess the danger to the jute trade from each of these substitutes; and

(2) to suggest improvement in the technology of jute goods with a view to improve their quality and reduce their price.

The Indian Central Jute Committee has undertaken an investigation on this point, but has to face great difficulties in getting facts in these days.

There is no doubt that substitutes have assumed great importance during the war. But forecasts about their future are premature. It is, however, important to note some tendencies in this respect.

If the war lasts long enough, the rationing of jute in the most important jute-consuming countries may decrease its subsequent peace-time importance, because of the introduction of substitutes to which the consumer may become accustomed by use over a sufficiently long period of time. This additional stimulus may even result in the development of a superior product made

of substitutes. Moreover, the abnormal war demand for substitutes may also increase the productive capacity of the substitute industries to such an extent that at the end of the war these industries will be forced to seek new markets in order to avoid a severe slump or may be kept up by tariffs and other similar devices. It is also worth noting that the Governments of some of the countries concerned are already planning to ensure the use of substitutes in place of jute even after the war. On the other hand, it may be recalled that in the last War also there was a search for jute substitutes in a number of countries. Several substitutes were found, but their cost of production was too high to compete with Indian jute. Consequently, these attempts, with the exception of a few, were given up after the War.

Another significant development in this war has been the attempt to grow jute on new territories. Experiments have now been initiated in Brazil, Argentine and the Soviet Union to grow jute on a commercial scale. It remains to be seen whether jute can be grown in any appreciable quantities in these countries and how far jute grown in these countries can compete in quality and price with Indian jute.

New Uses of Jute

The third important step in this direction is to explore new avenues for the use of jute. Experiments made abroad before the outbreak of war have already shown the possibility of using jute along new lines. The war itself has necessitated the manufacture of specialties such as the jute-cotton union fabric, jute tents, etc. Some of the Indian jute mills are now engaged in the manufacture of specialty fabrics, such as furniture material, scrim cloth, carpets, tarpaulin, etc. Readers of the Indian Central Jute Committee's *Monthly Bulletin* must have read about the promising and in some cases partially successful experiments in the Committee's Technological Research Laboratories to use jute in place of hemp and flax or for making garments or as a base for making file boards, or containers, etc. It is important to note that the war, while intensifying the search for substitutes of jute in many foreign countries, has at the same time created opportunities for trying jute in hitherto untried lines. The fullest advantage should be taken of such opportunities for directing the use of jute to the manufacture of new products or as substitutes for other fibres whose supplies in India have dwindled owing to the war. This subject forms an important part of the research programme of the Indian Central Jute Committee.

Agriculture

Last, but not the least, is the question of Agricultural improvements. It is obvious that improvement in the quality and yield of the fibre will enhance the competing power of jute. This aspect of the question, though sufficiently important in itself, has acquired enhanced importance on account of the developing menace of substitutes. The agricultural research programme of the Indian Central Jute Committee keeps this in full view.

Supply of Jute

One of the most difficult problems of jute has been the supply of raw jute. Even before the war, the jute market was seriously upset many a time owing to a bumper crop or an excessive supply against a reduced demand. Such maladjustments not only dislocate the jute market but also seriously affect the economic stability of the jute grower. The problem of supply still awaits a satisfactory solution. The war, however, has given some valuable experience. The bumper crop of 1940 was followed by compulsory restriction of the crop in 1941 and 1942. In the face of dwindling demand for jute the scheme of crop control initiated by the Government of Bengal has given fairly satisfactory results. Prices of raw jute have been well maintained and supplies have been fairly adjusted to demand. The manner in which this new weapon of crop control will be used in the post-war period is a question of first-rate importance to the future of jute. In order to throw some light on the problem of crop control, the Indian Central Jute Committee has undertaken an investigation into the elasticity of demand for jute.

Conclusion

The two most important problems likely to confront jute in the post-war period are: competition from substitutes on the demand side and control of the jute crop with a view to adjust supply to demand. It is clear that if jute goods are to recapture the lost ground after the war, immediate attention is necessary to the possibilities of making them cheaper and better and also more varied so that wider markets may be opened up.

LETTERS TO THE EDITOR

STATISTICAL FORMULÆ

It is perhaps worth while for statistical computers to have some fresh formulæ in addition to the familiar ones found in the common text-books. These formulæ can at least serve to open up new methods of checking results obtained by older methods. Here is a variance formula for k varieties, $x_1, x_2, \cdots, x_k$:

$$k^2\sigma^2=(k-1)\sum_{r=1}^{r=k}(x_r-m)^2 - \sum_{r=1}^{r=k}\sum_{s=1}^{r=k}(x_r-m)(x_s-m),\ (r\neq s) \qquad (1)$$

m being any number whatsoever.

It leads to the coefficient of intra-class correlation (R) for n families with varying number of members in each family, in a new form not noticed before:

$$R=1-\frac{\Sigma k_i^2\sigma_i^2}{\sigma^2\Sigma k_i(k_i-1)}, \qquad (2)$$

where k_i, σ_i^2 denote the number of members and the variance respectively in the i-th family and σ^2 is the general variance. The proof of this formula is immediate, if we set

$$P_i=\sum_{s=1}^{r=k_i}(x_{ir}-m)(x_{is}-m),\ (r\neq s)\ ;$$

and

$$S_i=(k_i-1)\sum_{s=1}^{r=k_i}(x_{ir}-m)^2,$$

where m is the general mean.

Then

$$R=\frac{\Sigma P_i}{\Sigma S_i}=1-\frac{\Sigma(S_i-P_i)}{\Sigma S_i}=1-\frac{\Sigma k_i^2\sigma_i^2}{\sigma^2\Sigma k_i(k_i-1)}.$$

It is readily seen that

$$R\geqslant -\Sigma k_i\sigma_i^2/\Sigma k_i(k_i-1)\sigma_i^2 \qquad (3)$$

Lastly, if we consider three groups of variates (x), (y), (z) arranged as in the following table:

	x_1	x_2	.	.	.	.	x_m	
y_1	z_{11}	z_{21}	.	.	.	.	z_{m1}	v_1
y_2	z_{12}	z_{22}	.	.	.	.	z_{m2}	v_2
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
y_n	z_{1n}	z_{2n}	.	.	.	.	z_{mn}	v_n
	u_1	u_2	.	.	.	.	u_m	

where $mv_i=z_{i1}+z_{i2}+\cdots+z_{mi}$, and $nuj=z_{j1}+z_{j2}+\cdots+z_{jn}$, we can write down the mean (M) and the variance (σ^2), of mn variates of the form $ax_j+by_i+cz_{ji}$ $(j=1, 2, \cdots m;\ i=1, 2, \cdots n)$, a, b, c being any arbitrary constants, thus:

$$M=a\bar{x}+b\bar{y}+c\bar{z}\ ; \qquad (4)$$

$$\sigma^2=a^2\sigma_x^2+b^2\sigma_y^2+c^2\sigma_z^2+2r_{xu}\,ac\,\sigma_u\sigma_x + 2r_{yv}\,bc\,\sigma_v\sigma_y\ ; \qquad (5)$$

in the usual notation of Statistics.

The proof follows by ordinary methods of expansion and summation. The last formula is useful in some genetic investigations.

Maharaja's College,
Mysore, A. A. Krishnaswami Ayyangar.
February 12, 1943.

SUPPRESSION OF RADIO INTERFERENCE FROM ELECTRIC MOTORS

THERE is experimental evidence to show that a d.c. operated motor, as a source of electrical interference, can be regarded as giving a *quasi*-continuous r-f spectrum. The electrical interference is due to these sparks between the brushes and the commutator. The frequency of the damped oscillations set up would depend not only on the inductance of the armature coil in one sector and its resistance and self-capacity, but also on the resistance of the air-gap across which the sparks take place. This resistance may vary between wide limits, especially under irregular spark conditions. The frequency component having the maximum intensity would lie in the region of the resonance frequency of the armature-sector.[1]

If it be accepted that the frequency components of the various high frequency waves originating, one after another, from the several sparks across the brush and the commutator, constitute a continuous spectrum, having the maximum energy in the region of the resonance frequency of the armature-sector, and that the observed peak values in the r-f noise field correspond to this frequency, it would be possible to displace the peak position towards a lower frequency region, thus minimising the noise field to a considerable extent. An attempt was made at minimising the noise field by this peak displacement method. The suggestion of such a displacement was originally in the work of Howe[2] on radio interference from traction systems.

Since noise-free reception is most desirable in the range, 7 Mc/s-20 Mc/s, which is most frequently employed for broadcast reception purposes, the work on noise suppression was carried out for this range. An Osler ceiling fan was chosen for the purpose. The armature of this fan had 36 commutator segments.

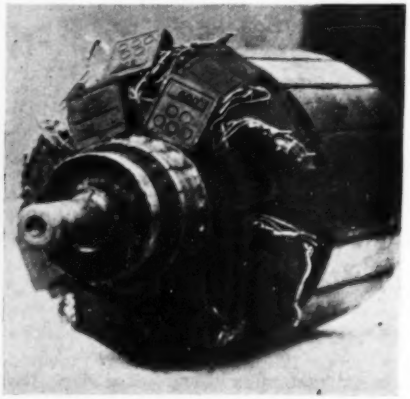


FIG. 1

Eighteen fixed condensers, each of value ·005 μf were inserted, each across a pair of commutator segments, successively and these were carefully fixed, so that the armature as a whole could smoothly rotate inside the field coil. A picture of the armature with fixed condensers is shown in Fig. 1.

The experiments with the Osler fan, with and without the fixed condensers inserted across consecutive pairs of commutator segments, showed considerable reduction in the noise field in the desired frequency range. In the lower frequency range, 3 Mc/s-6 Mc/s, the noise reduction was comparatively small, while in the still lower range, ·65 Mc/s-1·5 Mc/s, there was an increase in the noise field. The reduction in the noise field in the frequency range 7 Mc/s-20 Mc/s is shown in Fig. 2. The reduction in the acoustic output was also of

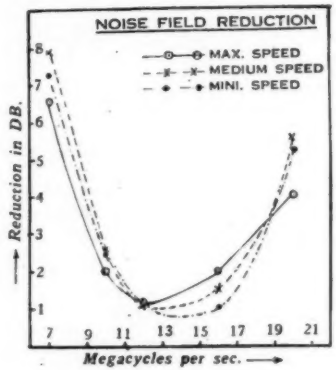


FIG. 2

the same order in the same range. This device of noise reduction can thus be regarded as satisfactory in this high frequency range.

The usual method of eliminating noise is to place a fixed condenser across the brushes of the motor. The results of such an experiment with a D.C. motor are given in Table I. The capacity-values of the condenser placed across the brushes of the motor, giving minimum noise for the different frequencies, are tabulated there.

TABLE I

D.C. Motor

Frequency (Mc/s)	Wavelength (Metres)	Capacity (μf)	Frequency (Mc/s)	Wavelength (Metres)	Capacity (μf)
·65	461·5	·5	4·0	75·0	·0005
·75	400·0	·5	5·0	60·0	·0005
·857	350·0	·5	6·0	50·0	·0005
1·05	285·7	·5	7·0	42·85	·0005
1·5	200·0	·5	10·0	30·00	·0005
3·0	100·0	·01	12·0	25·00	·0001
3·5	85·7	·01	16·0	18·75	·0001
			20·0	15·0	·0001

It can thus be said in a general way that the smaller capacities would be required for the higher frequencies and *vice versa*. The different motors having armatures of different inductance and self-capacity would, of course, require different values of capacity for minimum noise, even for the same frequency.

Physics Department,
Dacca University, S. R. KHASTGIR.
April 17, 1943. S. M. SEN.

1. Majumdar, S. C., Sen, S. M., and Khastgir, S. R., Communicated to *Ind. Jour. Physics*. 2. Howe, *Proc. I.R.E.*, 1937, **25**, p. 708

X-RAY DIFFRACTION STUDY OF CYBOTAXIS AT THE INTERFACE

THE structure of liquid in the interior may be taken as vaguely ordered statistical swarms of molecules, or it may be looked upon as a three-dimensional *quasi*-crystalline structure of ordered molecules, with molecules obeying gaseous laws in the interspaces, so that the composite arrangement shows both ordered and disordered properties simultaneously. The interface between two liquids, or between a liquid and a gas is, however, a region of permanently oriented molecules. The purpose of this note to study the nature of the interface structure, by X-ray diffraction method. For this purpose CuK_α radiation, filtered through nickel was allowed to strike the liquid-air interface. The beam was extremely narrow and about 2 mm. in diameter. It passed grazing the interface, with its lower edge just inside the liquid, so that the pattern of the liquid in bulk, may not come out with great prominence. The photographed diffraction pattern was microphotometered and the *intensity → interplanar spacing curve* was drawn. Fourier analysis of the main peak was done according to the method of P. Debye and H. Menke.[1] This gave the atomic distribution curve of the atoms, about any atom in the liquid, and for methyl alcohol, the atomic distribution curve showed maxima at 1·57, 2·94, 4·23, 5·64 Å, at 20° C. and at 1·63, 2·98, 4·36, 5·75 Å at 40° C. The peak at 1·57 Å is interpreted as arising from $(CH_3\ OH)_3$; that at 2·94Å, as arising from $(CH_3 OH)_2$, that peak at 4·36 Å has its origin in $(CH_3\ OH)$ and the last peak is due to oriented molecules at the interface. Values of integrated intensities under the peaks are proportional to the relative number of molecules of the different species. With a fixed arrangement the integrated area under the last peak does not vary with temperature; while the relative integrated areas under the first three peaks change considerably with temperature. Assuming the number of triple molecules as small, the ratio of the polymers with 1 and 2 molecules, as obtained from the above analysis of the diffraction pattern, comes out as 0·25 and 0·20, at 20° and 40° C. respectively. The same values calculated from association factor 'a' are 0·220 and 0·163 at the two temperatures mentioned ($a = 1·82$ at 20° C. and 1·86 at 40° C.).

Dept. of Physics,
Science College,
Patna, BHOLANATH GHOSH.
March 30, 1943.

1. P. Debye and H Menke, *Phys. Zeits.*, 1930, **31**, 797.

PREPARATION OF SUB-IODIDES OF CADMIUM AND ZINC

WOEHLER AND RODEWALD[1] prepared calcium sub-iodide in 1904. Preservation of sub-iodides is difficult. Samuel and Zakiuddin[2] succeeded in preserving calcium sub-iodide under carbon disulphide for some time. Kupfer[3] found that the compound could be preserved for a fairly long interval in parafinol and he studied X-ray diffraction of the sub-iodide.

Employing the method suggested by Samuel and Zakiuddin, the sub-iodides of cadmium and zinc have been successfully prepared by the author of the note. Iodine and cadmium of C.P. quality were taken in the ratio of their equivalent weights and placed in a steel bomb provided with an air-tight screw. The bomb was heated in an electric furnace to about 1000° C. for 10 hours and cooled suddenly by immersion in water. The resulting greenish yellow powder was found, on chemical analysis, to be cadmium sub-iodide. It could be preserved for over a week under carbon disulphide. Zinc sub-iodide, prepared in a similar way and easily preserved under carbon disulphide, was black in colour.

Absorption spectra of these sub-halides will be studied later.

Meteorological Office,
Poona 5, KHALILULLAH SIDDIQI.
February 13, 1943.

1. Woehler and Rodewald, *Z. f. anorg. Chemie*, 1904, **61**, 54. 2. Samuel, R., and Zakiuddin, *Proc. Ind. Acad. Sci.*, 1935, **1**, 723. 3. Dr. Kupfer, Private Communication to Dr. Zakiuddin, 1936.

A NEW PHOTOMETRIC METHOD FOR THE ESTIMATION OF TOCOPHEROL (VITAMIN E)

PAUL MEUNIER AND ANDREE VINET[1] pointed out that a solution of α-tocopherol in alcohol (a few γ) when mixed with a reagent composed of one drop of a 1 per cent. solution of potassium ferricyanide and one drop of 1·5 per cent. solution of ferric chloride mixed with 1 c.c. chloroform and made up to 10 c.c. with absolute alcohol, developed a blue colour. Experiments were conducted to find out the suitability of this colour production as a photometric method for the estimation of tocopherol in oils.

A standard solution of α-tocopherol in absolute alcohol was prepared by methyl-alcoholic alkali saponification of α-tocopherol acetate according to the method of Emmerie.[2] The solution was standardised by the $FeCl_3$-αα'-di-

pyridyl method of Emmerie and Engel[3] using absolute alcoholic solutions of the reagents and the Pulfrich photometer with S. 50 filter and 1 cm. cell. During these estimations it was found that more consistent and reproducible results could be obtained by using a mixture of the solutions of ferric-chloride and αα′-dipyridyl for colour development rather than by using them one after another. The mixed reagent can be prepared by dissolving 16 mg. ferric-chloride and 20 mg. αα′-dipyridyl in 16 c.c. pure absolute alcohol, and using 2 c.c. of this every time for the blank and the experimental. According to this procedure α-tocopherol upto 100 γ can be estimated.

THE FERRIC CHLORIDE-POTASSIUM FERRICYANIDE REACTION

A standard graph (Fig. 1) showing the relationship between the content of α-tocopherol and the extinction coefficient was drawn. The intensity of the colour is proportional to the extinction coefficient and obeys Beer's law and the colour is stable over long periods. In all these estimations the colour was developed in 10 c.c. flasks. Filter S.72 and 1 cm. cells were used. The minimum quantity of the reagents were found out to be 0·4-0·5 c.c. of each of 0·4 per cent. ferric-chloride and 0·25 per cent. potassium ferricyanide solution up to 100 γ of α-tocopherol.

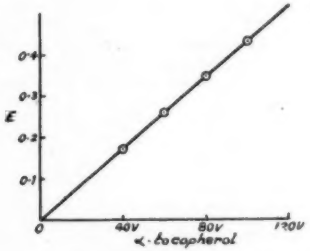


FIG. 1

$FeCl_3$, K_3FeCN_6
10 cm.,[3] 1 cm. cell
(S. 72)

The reagent should be prepared fresh before each estimation by mixing together 0·5 c.c. of 0·4 per cent. $FeCl_3$ solution and 0·5 c.c. of 0·25 per cent. potassium ferricyanide solution adding 1 c.c. pure chloroform and making up to 11 c.c. with purified absolute alcohol (free from reducing substances). 5 c.c. of this reagent is used for blank and experimental. The reagent deteriorates rapidly and assumes a dark colour especially in the presence of light.

For the standardisation, known amounts of α-tocopherol in alcoholic solution were taken and the extinction coefficient was measured after developing the blue colour. Measurements can be made immediately after the reaction. A blank should be prepared every time.

Experiments were conducted with wheat germ oil saponified by methyl alcoholic KOH. The values (Table I) for the tocopherol content as estimated by the $FeCl_3$-$K_3Fe(cy)_6$ method agree well with those determined by αα′-dipyridyl method.

TABLE I

Vol. of solution in absolute alcohol	αα′-dipyridyl method		$K_3F_3(cy)_6$ method	
	Ext. coefficient	γ α-tocopherol	Ext. coefficient	γ α-tocopherol
0·2 c.c.	0·097	28	0·125	29
0·4 c.c.	0·210	57·5	0·250	58
0·6 c.c.	0·315	85	0·370	85

It is clear from the above table that the extinction coefficient for the same concentration of α-tocopherol is greater by the $K_3Fe(cy)_6$ method than by the αα′-dipyridyl. A wheat germ oil solution in purified petroleum ether, when treated by the method of Parker and McFarlane[4] also gave similar results though as pointed out by McFarlane, the values were slightly higher than those obtained when the oil was saponified with alkali.

A pharmaceutical preparation (Ephynal, Roche) containing α-tocopherol acetate also gave concordant results by both methods [αα′-di-pyridyl and $K_3Fe(cy)_6$].

The tocopherol content of some vegetable oils by this method [$K_3Fe(cy)_6$] is being investigated.

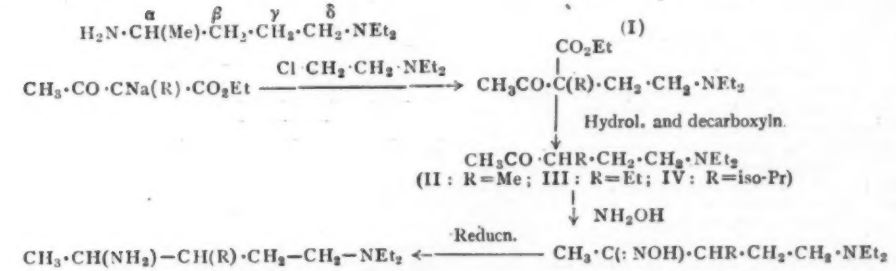
Dept. of Biochemistry,
Indian Institute of Science,
Bangalore, K. RAMACHANDRAN.
May 1, 1943. Y. V. S. RAU.

1. Paul Meunier and Andree Vinet, *Comptes rendus*, 1940, **211**, 611–13. 2. Emmerie, *Rec. trav. him. pays. Bays.*, 1940, **59**, 246–48. 3. Emmerie and Engel, *Ibid.*, 1938, **57**, 1351–58. 4. Parker and McFarlane, *Can. J. Res.*, 1940, **18, B.** 405.

SYNTHESIS OF NEW ANTIMALARIALS RELATED TO ATEBRIN, PART I

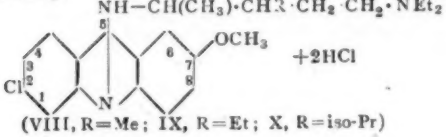
IN atebrin, the side chain (I), *viz.*, δ-diethylamino-α-methyl-butylamine is attached to the carbon atom in position 5 of the acridine nucleus. It is interesting to note[1] that the nature of the aliphatic side-chain in position 5 of the 2-chloro-7-methoxy acridine plays a very important role in determining the chemotherapeutic index of various compounds of this series. The change from .NH.$(CH_2)_4$.NEt_2 to .NH.CH $(Me.(CH_2)_2.NEt_2$ reduces the index from 20 to 6·6, whilst that from .NH.$(CH_2)_5$.NEt_2 to .NH.CH.(Me).$(CH_2)_3$.NEt_2 raises the value from 6 to 15. It was, therefore, considered desirable to study the effect of different alkyl groups when introduced in position β, γ and δ of the side chain (I), on the antimalarial activity of the resulting compounds.

With this object in view, in this part, acridine derivatives (VIII), (IX) and (X) containing alkyl groups (R = Me, Et and isopropyl) in the β-position of the side chain, have been prepared as follows;



(V: R = Me; VI: R = Et; VII: R = iso-Pr). (II: b.p. 120°/25-30 mm., oxime, b.p. 85-90°/2-3 mm.; III: b.p. 100-105°/2-3 mm.; oxime b.p. 95-100°/2-3 mm.; IV: b.p. 115-20°/2-3 mm.)

The three diamines (V, b.p. 85-90°/2-3 mm.; VI, b.p. 95-100°/2-3 mm.; VII, b.p. 110-15°/2-3 mm.) have been condensed with 2: 5-dichloro-7-methoxy-acridine to give compounds (VIII, hydrochloride m.p. 258-60° decomp.), (IX, hydrochloride m.p. 265-67° decomp.), and (X, hydrochloride decomposing at 275°) respectively.



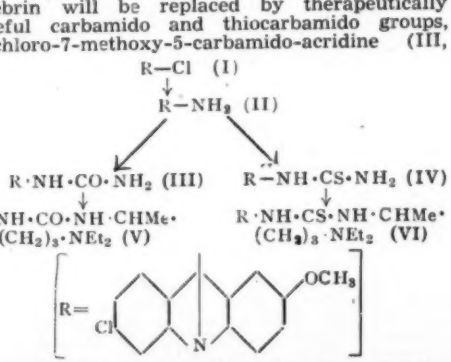
(VIII, R=Me; IX, R=Et; X, R=iso-Pr)

Organic Chemistry Section,
Dept. of Pure & Applied Chemistry,
Indian Institute of Science,
Bangalore, P. C. GUHA.
March 29, 1943. S. P. MUKHERJI.

[1] Henry, *J. Soc. Chem. Ind.*, 1936, p. 115.

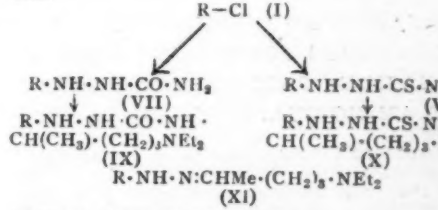
SYNTHESIS OF NEW ANTIMALARIALS RELATED TO ATEBRIN, PART II

WITH a view to synthesising compounds like (V and VI) in which the imino-group in atebrin will be replaced by therapeutically useful carbamido and thiocarbamido groups, 2-chloro-7-methoxy-5-carbamido-acridine (III, m.p. 330-331°) and 2-chloro-7-methoxy-5-thiocarbamido-acridine (IV, m.p. 285-287°) have been prepared by the action of 2-chloro-5-amino-7-methoxy acridine (II), m.p. 265-267° (prepared according to the method of Adien, Albert and Bruce Ritchie[1] with urea and thiourea respectively. The urea and thiourea derivatives of the acridine compounds, *viz.*, compounds (V) and (VI) due to their insolubility could not, however, be made to react with δ-diethylamino-α-methyl-butylamine.



2 : 5-Dichloro-7-methoxyacridine reacting with semicarbazide and thiosemicarbazide has furnished the corresponding semicarbazide and thiosemicarbazide derivatives of the acridine, *viz.*, compounds (VII, m.p. 214-225°), and (VIII, m.p. 170-172°) respectively. Compounds (VII) and (VIII) in their turn, have been made to react with δ-diethylamino-α-methyl-butylamine to furnish compounds (IX), hydrochloride, m.p. 228-229° decomp., and (X) hydrochloride, m.p. 196-197° decomp. The pharmacological study of these semicarbazide and thiosemicarbazide derivatives of the chloro-methoxy-acridine, as also of the compounds (IX) and (X) which are analogous to the well-known anti-malarial drug atebrin, with the imino-group in position 5 replaced by semicarbazide and thicsemicarbazide groupings respectively, will, it is expected, furnish interesting results.

The acridine compound (XI) possessing a hydrazine residue in place of -NH-, and otherwise identical with atebrin was prepared by condensing 2: 5-dichloro-7-methoxy-acridine with NH_2-N = CH(CH$_3$)-(CH$_2$)$_3$-NEt$_2$ (XII), b.p. 90-95°/2-3 mm. All these acridine compounds are awaiting pharmacological examination.

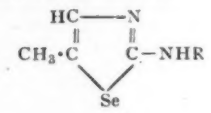


Organic Chemistry Section,
Dept. of Pure & Applied Chemistry,
Indian Institute of Science,
Bangalore, P. C. GUHA.
March 29, 1943. S. P. MUKHERJI.

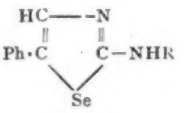
[1] Adieu, Albert and Bruce Ritchie, *J. Soc. Chem. Ind.*, 1941, p. 120.

SYNTHESIS OF SULPHANILAMIDO SELENAZOLES

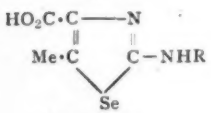
p-ACETAMINOBENZENE-SULPHOCHLORIDE has been made to react with (i) 2-amino-4-methylselenazole, (ii) 2-amino-4-phenyl-selenazole, (iii) 2-amino-4-methyl-5-carboxy-selenazole and seleno-hydantoin, to give 2-(*p*-acetamino-benzene-sulphonyl)-amino-4-methyl selenazole (I), m.p. 228-29°; 2-(*p*-acetamino-benzene-sulphonyl)-amino-4-phenyl selenazole- (II), m.p. 238-239°; 2-(*p*-acetamino-benzene-sulphonyl)-amino-4-methyl-selenozole-5-carboxylic acid (III), m.p. 238-39°; and 2-(p-acetyl-amino-benzene-sulphonyl)-amino-seleno-hydantion (IV), m.p. 263-64° (decomp.); respectively. The acetyl-compounds (I), (II) and (III) gave 2-(*p*-amino-benzene-sulphonyl)-amino-4-methyl-selenazole (V), m.p. 222-23°; 2-(*p*-amino-benzene-sulphonyl)-amino-4-phenyl-selenazole (VI), m.p. 231-32°; and 2-(*p*-amino-benzene-sulphanyl)-amino-4-methyl-selenazole-5-carboxylic acid (VII), m.p. 231-32°. Their toxicity and antibacterial properties are being studied.



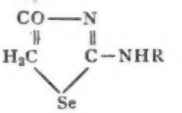
(I, V)



(II, VI)



(III, VII)



(IV)

[I-IV, R = $-SO_2 \cdot C_6H_4-NHAc$
V-VII, R = $-SO_2 \cdot C_6H_4 \cdot NH_2$]

Organic Chemistry Section,
Dept. of Pure & Applied Chemistry,
Indian Institute of Science,
Bangalore, P. C. GUHA.
March 12, 1943. A. N. ROY.

SYNTHESIS OF SULPHANILAMIDE COMPOUNDS CONTAINING SEMI-CARBAZIDE-, THIOSEMICARBAZIDE- AND AMINO-GUANIDINE-RESIDUES

SULPHANILAMIDE compounds with urea, thiourea and guanidine have already been made. Alles[1] has made the interesting observation that aminoguanidine shows much less toxicity than guanidine. Sulphanilamide compounds of the *amino*-derivatives of urea, thiourea and guanidine or, in other words, of semicarbazides, thiosemicarbazides and aminoguanidines, have now been prepared.

The following compounds as also acetyl derivatives of III-VIII have been made:—

$NH_2-C(NH)-NH-NH-SO_2-C_6H_4-NH_2COCH_3$ (I)
$NH_2-C(NH)-NH-NH-SO_2-C_6H_4-NO_2$ (II)
$NH_2-CO-NH-NH-SO_2-C_6H_4-NH_2$ (III)
$PhNH-CO-NH-NH-SO_2-C_6H_4-NH_2$ (IV)
$p-CH_3C_6H_4-NH-CO-NH-NH-SO_2-C_6H_4-NH_2$ (V)
$NH_2-CS-NH-NH-SO_2-C_6H_4-NH_2$ (VI)
$PhNHCS-NH-NH-SO_2-C_6H_4-NH_2$ (VII)
$p-CH_3-C_6H_4-NH-CS-NH-NH-SO_2-C_6H_4-NH_2$ (VIII)

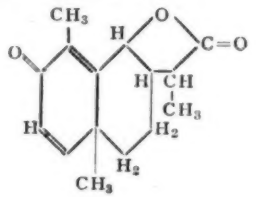
The pharmacological studies of these compounds are in progress.

Organic Chemistry Section,
Dept. of Pure & Applied Chemistry,
Indian Institute of Science,
Bangalore, P. C. GUHA.
March 12, 1943. K. L. HANDA.

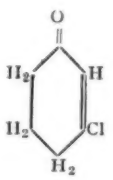
1. *J. Pharm. Soc.*, 1926, **28**, 251.

SYNTHESIS OF SANTONIN

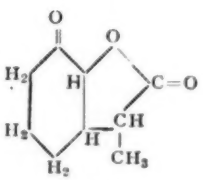
SANTONIN, the classical remedy for the treatment of ascaris or round-worms and oxyuris, is the chief constituent of the leaves of *Artemisia maritima* Linn. The chemical investigation of santonin has been carried out by Clemo, Haworth and Walton.* We have now achieved the synthesis of santonin by the series of reactions outlined below.



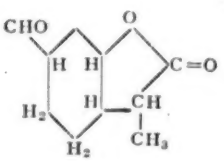
(I)



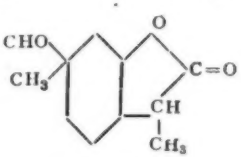
(II)



(III)



(IV)



(V)

3-Chloro-Δ^2-cyclohexen-1-one (II) on treatment with the Sodium Derivative of methyl malonic ester followed by hydrolysis with 30 per cent. sulphuric acid in dilute alcohol gave the keto lactone (III), which on condensation with ethyl formate gave (IV). Methylation of

(IV), effected by the treatment of its sodium compound with methyl iodide, gave (V). Condensation of (V) with methyl ethyl ketone took place, fortunately, in the desired direction and gave rise to santonin (I). The compound thus prepared had m.p. 171° C. and did not depress the m.p. of an authentic sample of santonin. It formed a semicarbozone identical with santonin semicarbozone. The synthetic product is, however, optically inactive. Details of the synthesis will be published shortly.

Maharaja Pratapsingh Chemical Laboratory, S. P. College, Poona 2, *May* 10, 1943.

(Miss) K. Paranjape.
N. L. Phalniker.
B. V. Bhide.
K. S. Nargund.

* Clems, Haworth and Walton, *J.C.S.*, 1929, 2368; 1930, 2579.

ISO-AMYL ALCOHOL AS A SOLVENT FOR THIOCHROME IN THE CHEMICAL ASSAY OF VITAMIN B_1

In the thiochrome method for the estimation of vitamin B_1 (thiamine), iso-butyl alcohol is employed to extract the thiochrome formed from thiamine by oxidation with alkaline ferricyanide. Some difficulties in obtaining supplies of iso-butyl alcohol emphasised the need for a substitute. But no references are available in the literature about any other solvent being used in the place of iso-butyl alcohol for extraction of thiochrome. Preliminary trials with some common laboratory solvents showed that iso-amyl alcohol could be useful. Supplies of iso-amyl alcohol are easier to obtain and its use is more economical because it is cheaper and the recovery of used solvent is higher due to its much lower solubility in water. These points indicated the promising use of iso-amyl alcohol, and further experiments were carried out to establish its utility. For purposes of comparison, iso-amyl and iso-butyl alcohol were used in the estimation of vitamin B_1 on two aliquots of the same extract of each biological material obtained by employing a modified method of Swaminathan (1942). The relevant results obtained with various types of biological material are given in Table I.

TABLE I

Name of the Biological material	Iso-butyl alcohol		Iso-amyl alcohol	
	Vitamin B_1 μg./g.	Recovery of added vitamin per cent.	Vitamin B_1 μg./g.	Recovery of added vitamin per cent.
Cereals:				
1. Wheat, whole	4·4	94	4·3	96
2. Rice, raw milled	1·4	91	1·5	95
Pulses:				
3. Bengal gram	5·0	95	4·8	95
4. Red gram	1·2	88	1·1	87
5. Soya bean	1·3	95	1·3	93
Nuts:				
6. Groundnut	9·2	93	9·3	96
Vegetables:				
7. Carrot	0·53	94	0·58	96
8. Cabbage	0·67	88	0·69	90
Animal tissue:				
9. Liver, sheep	3·1	88	3·4	89
Yeasts:				
10. Yeast, brewer's, dried	50·0	100	48·1	96
11. Yeast extract	17·1	95	18·0	93

These results show that the amount of vitamin B_1 and the recovery of added vitamin are comparable with both the alcohols. The intensity of fluorescence was similar in all cases. It was found that the values for blanks with iso-amyl alcohol were in general lower than those obtained with iso-butyl alcohol, indicating that iso-amyl alcohol extracts interfering fluorescent materials to a lesser extent than iso-butyl alcohol. A study of the effect of the duration of shaking showed that all the extractable thiochrome was removed in one minute and there was no destruction even upto three minutes' shaking. Thus, thiochrome in iso-amyl alcohol is more stable than in iso-butyl alcohol since Conner and Straub (1941) have shown that the duration of shaking with iso-butyl alcohol should not exceed two minutes as there was some lowering in the intensity of fluorescence on shaking for three minutes. Hence iso-butyl alcohol can be substituted with advantage by iso-amyl alcohol in the extraction of thiochrome from reaction mixtures for the chemical estimation of vitamin B_1.

Nutrition Research Laboratories,
Indian Research Fund Association,
Coonoor,
April 17, 1943. K. K. P. Narasinga Rao.

1. Conner, R. T., and Straub, G. J., *Ind. Eng. Chem., Anal. Ed.*, 1941, **13**, p. 380. 2. Swaminathan, M., *Ind. Jour. Med. Res.*, 1942, **30**, 263.

THE ADRENALINE AND ASCORBIC ACID CONTENTS OF THE SUPRARENAL GLANDS OF SLAUGHTERED ANIMALS

The quantitative estimation of Adrenaline in the suprarenal glands of slaughtered animals is of considerable significance at the present time in view of the large-scale production of this hormone which is now being attempted by several firms in India. Neither the chemical nor the biological methods of estimation are entirely free from criticism. Among the chemical methods (colorimetric) the most popular has been that originally worked out by Folin which, however, is extremely unspecific for the compound: the more accurate seems to be the persulphate colour reaction, which was worked out into a quantitative method by Barker,[2] using the tintometer. In the present investigation both the Folin and Persulphate methods (the latter with modifications to suit estimations with the Dubosq colorimeter) were employed. Since ascorbic acid is intimately

associated with adrenaline in the adrenal glands and is in fact one of the most important interfering factors in the estimations of the latter with the Folin's reagent, a quantitative estimation of this vitamin was also undertaken by two methods, *viz.*, by titration with (*a*) dibromophenol-indophenol and (*b*) iodine solution, the latter of which, being unspecific, gave uniformly higher values. Tables I and II represent typical figures for the adrenaline and the vitamin C contents of cattle and sheep.

It will be seen that the values for adrenaline by the Folin's method are considerably higher than those by the Persulphate method. The yield of adrenaline from natural sources has been claimed to be quantitative[3]: the figures by the latter method agree better with the actual yields obtained in this laboratory. It will also be evident from a perusal of the tables that cattle glands contain more adrenaline (expressed in terms of mg. of adrenaline per gram of gland) than the sheep glands, but are relatively poorer in ascorbic acid.

For the preparation of cortical hormones, which are being investigated in this laboratory under the auspices of the Board of Scientific and Industrial Research, the ideal method appeared to be to start with the dissected cortex, and this led to a careful study of the relative distribution of adrenaline and vitamin C in the cortex and in the medulla separately. The results obtained should be of

TABLE I
Cattle Glands (Whole)

No.	*Adrenaline* Weight (mg.) per gram of gland		*Vitamin C* Weight (mg.) per gram of gland	
	Folin's	Persulphate	Indicator	Iodine
(1)	2·95	1·83	0·91	1·25
(2)	3·00	1·84	0·89	1·17
(3)	3·20	1·87	0·93	1·26
Average	3·05	1·85	0·91	1·23

TABLE II
Sheep Glands (Whole)

No.	*Adrenaline* Weight (mg.) per gram of gland		*Vitamin C* Weight (mg.) per gram of gland	
	Folin's	Persulphate	Indicator	Iodine
(1)	2·51	1·50	1·28	1·78
(2)	2·65	1·62	1·37	1·85
(3)	2·45	1·60	1·26	1·67
Average	2·54	1·57	1·30	1·73

TABLE III
Dissected Cattle Glands

Percentage of Medulla	*Adrenaline* (mg. per gram of tissue)				*Vitamin C* (mg. per gram of tissue)			
	Medulla		Cortex		Medulla		Cortex	
	Folin	Persulphate	Folin	Persulphate	Indicator	I_2	Indicator	I_2
(1) 28·9	6·91	4·62	1·37	0·39	0·96	1·40	1·03	1·42
(2) 28·2	6·64	4·74	1·25	0·36	0·91	1·37	0·96	1·35
(3) 29·4	6·17	5·06	1·19	0·35	0·93	1·22	1·14	1·37
Average 28·8	6·57	4·80	1·27	0·37	0·93	1·33	1·06	1·38

TABLE IV
Dissected Sheep Glands

Percentage of Medulla	*Adrenaline* (mg. per gram of tissue)				*Vitamin C* (mg. per gram of tissue)			
	Medulla		Cortex		Medulla		Cortex	
	Folin	Persulphate	Folin	Persulphate	Indicator	I_2	Indicator	I_2
(1) 19·1	6·37	5·53	1·12	0·30	0·90	1·39	1·34	1·74
(2) 18·9	6·41	5·57	1·19	0·35	1·01	1·43	1·53	1·92
(3) 19·1	6·74	5·46	1·19	0·28	1·07	1·55	1·49	1·89
Average 19·0	6·50	5·52	1·17	0·31	0·99	1·46	1·45	1·87

great interest. Tables III and IV represent typical values. They show clearly that the amount of adrenaline present in the medulla alone is about 82 per cent. of the total amount of this hormone present in the whole gland and actual experiments carried out in this laboratory on the recovery of adrenaline from the separated medulla have confirmed this observation. It will also be noted that the disparity between the values for adrenaline by the Folin and Persulphate methods is considerably larger in the cortex than in the medulla—a disparity which is too great to be explained merely by the difference between the vitamin C contents of the cortex and the medulla.

The expenses of this investigation have been met entirely from funds supplied by the Board of Scientific and Industrial Research to whom our grateful thanks are due.

Presidency College, Madras, *April* 26, 1943.

B. B. DEY.
P. S. KRISHNAN.
V. SREENIVASAN.

1. Folin, Cannen and Denis, *J. Biol. Chem.*, 1913, **13**, 477. 2. Barker, Eastland and Evers, *Biochem. J.*, 1933, **26**, 2129. 3. Barger, "Organic Chemistry in Biology and Medicine", 1930.

REICHERT VALUE OF BUTTER-FAT

FROM time to time investigators in various parts of India publish Reichert values and other constants, determined on butter-fat, prepared from the milk of single animals. These figures often suggest that the Provincial standards for Reichert value are too high and they are much quoted by the defence in prosecutions for the sale of adulterated butter or ghee.

I think the explanation may be a very simple one. A chemist wishing to determine such figures will usually ask a local cattle owner to bring an animal to his laboratory for milking under supervision. Quite a small amount of milk will provide the amount of fat needed for analysis; but if the cattleman is told that this is all that is required he will, quite naturally, send an animal which gives only a small yield. It is an accepted fact that the Reichert value of butter-fat falls rapidly as the animal approaches the end of the period of lactation; so that butter-fat obtained in this way is not representative of the butter-fat from normal animals.

Published figures purporting to be the Reichert values of the milk of single animals should be accepted only with the greatest reserve in the absence of a precise statement of either the stage of lactation of the animals, or the daily yield of milk at the time of sampling.

Laboratories of the Government Analyst, Guindy, *May* 3, 1943.

HERBERT HAWLEY.

2-N¹-SULPHANILAMIDO-5-ISOPROPYLTHIAZOLE IN MONKEY MALARIA

IN a previous communication[1] effectiveness of (i) 2-N¹-Sulphanilamido-5-ethylthizole and (ii) N¹-methyl-sulphathiazole in monkey malaria was reported. In the course of study of several 2-N¹-Sulphanilamido-5-alkyl-thiazoles in monkey malaria, 2-N¹-Sulphanilamido-5-isopropylthiazole has been found to be effective in eradicating the malarial infection in monkeys. These compounds were prepared by Ganapathi *et al.*[2] in the Chemotherapy Department of the Haffkine Institute and supplied by that department.

Rhesus monkeys infected with K$_o$ strain of *Plasmodium knowlesi* were used for the purpose of the experiments. Parasites in the peripheral blood were enumerated daily and when the infection had reached a moderate degree (about ten parasites per 10,000 R.B.C.'s) the drug was administered orally, in the form of tragacanth suspension through a stomach tube. The dose administered was 1 gm. given once a day for three consecutive days. It was observed that after administration of the drug the parasites disappeared completely from the peripheral blood in four days. In a second set of experiments a dose of 1 gm. was administered orally only once, and here also the parasites disappeared from the peripheral blood in four days. In a third set of experiments a dose of 0·5 gm. was administered orally only once and in this case also the parasites disappeared from the peripheral blood in four days. It was further observed that there was no relapse in monkeys treated with this drug while the controls similarly treated with atebrin showed a relapse. The question of radical cure was, therefore, investigated in case of animals treated with this drug. The blood of animals treated with a dose of 1 gm. given only once was found to be non-infective to normal animals three weeks after the disappearance of the parasites from the peripheral blood, and the animals so treated were as susceptible to fresh infection as normal animals. The progress of the infection on reinfection was same as in the first infection, showing thereby that the monkeys did not acquire any immunity due to the previous infection.

It was, therefore, concluded that 2-N¹-Sulphanilamido-5-isopropylthiazole causes a disappearance of parasites from peripheral blood and probably produces a radical cure in *Rhesus* monkeys infected with *P. knowlesi*. The dose required for the eradication of the parasites indicates the therapeutic usefulness of the drug in the treatment of human malaria. Investigations on this point along with the pharmacology of this drug are in progress and will be reported later.

Dept. of Pharmacology, Haffkine Institute, Bombay, *March* 25, 1943.

B. V. PATEL.

1. Patel, B. V., *Curr. Sci.*, 1942, **11**, 187. 2. Ganapathi, K., Shirsat, M. V., and Deliwala, C. V., *Proc. Ind. Acad. Sci.*, 1941, **14A**, 630.

CRYPTOSTEGIA GRANDIFLORA, R. Br. A RUBBER-BEARING PLANT FOUND IN INDIA

THE present shortage of rubber, a vital strategic material, has focussed attention on sources other than *Hevea braziliensis*. Interest in such investigations was shown so early as sixty years ago but the supremacy of Hevea precluded any commercial exploitation of even the most promising alternatives. One such plant is *Cryptostegia grandiflora*, R. Br.[1] Its analysis was published in 1907 by Dunstan[2] who reported over 80 per cent. of rubber in the coagulum together with 9 per cent. of resin. The quality of the rubber also was favourably reported upon.

Now, of course, any substitute for Hevea is welcome practically regardless of cost. The U.S.A., for example, is covering a portion of her requirements from a South American plant, Guayule (*Parthenium argentatum*) and Soviet Russia is encouraging the cultivation of dandelion (*Taraxacum-koksaghyz*) to minimise rubber imports. Similarly, in India, a list of plants whose study might lead to a promising source has been compiled by Dent[3] who, in his survey, includes, among others, *Cryptostegia grandiflora*.

Cryptostegia grandiflora is stated to be a native of Madagascar and has become naturalised in India, where it is found in the plains and up to about 2,000 feet. It is a large evergreen, woody climber, with copious milky juice, often cultivated in the gardens for its flowers. The leaves are opposite, 2-4 inches long, 1·5-2 inches broad, elliptic, rather thick, glossy and green; flowers about 2 inches across of a pinkish purple colour, showy, fruit 4-5 inches long by 1 inch broad near the base, woody, angled or winged. Flowers during hot and rainy seasons. Though susceptible to extremes of heat and cold it grows well in all climates with rainfall from half an inch to 83 inches but it appears to thrive best in places with rainfall averaging between 20-40 inches a year.

The latex of *Cryptostegia* obtained from different parts of the country has been examined and the results are tabulated below:—

	Rainfall in inches during 1942	% Coagulum in latex	% in Coagulum	
			Rubber	Resin
Multan	12·80	17·9	79·8	12·5
Delhi	37·73	12·6	88·0	12·0
Rajputana	24·89	27·0	81·9	11·5
Poona	31·28	26·56	86·0	8·3
Gwalior*	30·33	..	74·2	9·7
Jalaum*	31·45	.	84·5	9·0
Coimbatore	20·38	17·06	86·4	12·4
Bombay*	70·63	..	66·7	10·5
Dehra Dun	99·10	15·6	80·0	16·8
Hevea braziliensis (for comparison)		40·0	89·0	4·1

* Taken from Dunstan.[2]

The percentage of rubber in the coagulum thus averages about 80 per cent. and that of resins 10 per cent., apparently irrespective of the climate and soil where cryptostegia grows. Also, the latex from the plant in some localities is thinner, yielding less of coagulum than those from others. At first it would appear that the lattices obtained from regions with rainfall between 20 and 35 inches a year are richer in coagulum than those from either the drier or the moister climates. This may be so, but with our scanty data, it is unsafe to generalise especially as the age and season factors have to be allowed for. Probably, the latex from a younger plant is thinner than that of a mature plant. All these need further investigation.

Cryptostegia grandiflora as a war-time substitute for Hevea has the further advantage in its reported ability to yield latex within a year of its sowing. Harvesting cryptostegia is thus within the span of an agricultural operation and this very great advantage of the time factor needs no emphasis. But, for large-scale successful tapping or the extraction of rubber from small woody plants of the size of cryptostegia new methods are needed. Such methods were till now not developed and this is the chief reason for the plant, cryptostegia not establishing itself as a source of rubber. The orthodox methods of tapping fail with shrubs which at one cutting yield no more than a few drops of the latex. In the absence of suitable technique for tapping, all the other advantages of cryptostegia, *viz.*, that, unlike Hevea, it is not fastidious about the climate and soil, that it can be raised from seeds or cuttings and that it can be tapped within a year, will be of no more than academic interest. Some efforts have already been made to evolve a suitable technique. For example, the extraction of the rubber by solvents is possible but the quality of the rubber so obtained, is stated to be poor. Similarly the autoclaving of the crushed and powdered plant has yielded low results. The method of employing disintegration and flotation process, developed for winning rubber from Guayule, has not yet been successfully employed in the case of cryptostegia.

Close-up view of leaves

Releasing the rubber from the woody shrubs might be possible after disintegration brought about through selective attack by insects,

fungus or enzymes on woody parts, and this line of attack is suggested as a promising line of investigation. The author has written this note, primarily to draw the attention of scientific workers to the possibilities of cryptostegia and the problem of its tapping. Apart from its scientific interest, any solution to this problem would be of very great service to the country just now.

Forest Research Institute,
Dehra Dun, K. L. BUDHIRAJA.
February 19, 1943.

1. Anon, 1882, "New India Rubber Plant," *Indian Forester*, **10**, 202. 2. Dunstan, W. R., "*Cryptostegia grandiflora* Rubber from India," *Bull. Imp. Inst.*, 1907, **5**, 371 Dunstan, W. R., "The Rubber of *Cryptostegia grandiflora*," *Bull. Imp. Inst.*, 1912, **10**, 210. 3. Dent, T. V., "Possible War-time Sources of Vegetable Rubber in India," *Ind. For. Leaflet* (*Silviculture*), 1942, No. 22.

AN EQUATION FOR THE PERCOLATION OF WATER IN SODIUM-CALCIUM SOILS

IT is well known that of the various kinds of soils sodium soil is the least pervious to water. When a calcium soil is treated with sodium carbonate the exchangeable calcium is replaced by sodium in the soil, and differing amounts of sodium carbonate added lead to the formation of different grades of sodium-calcium soils. The adsorbed sodium has been found to be responsible for the impermeability of alkali soils. An attempt has been made to study in closer detail the effect of varying amounts of exchangeable sodium on the permeability of calcium soils.

In his studies on the permeability of alkali soils A. E. Harris[1] pointed out that the permeability is logarithmically related to a value "S" which represents the degree of saturation of the soil complex with respect to sodium ion, which may be expressed by an equation of the form:

$$Y = ae^{-b}S, \qquad (1)$$

where Y = rate of percolation of water,

$$S = \frac{\text{exchangeable sodium}}{\text{base-exchange capacity}} \times 100$$

and a and b, constants.

The applicability of this formula has been tested in a number of soils. Pure mineral non-calcareous calcium soils were prepared by digesting the soil sample first with N-NaOH, and then with 0·05 N-HCl. After washing away the soluble matter it was leached with N-$CaCl_2$. The free salt was removed by repeated washing with distilled water until the filtrate gave no test for chloride. The residue was dried at 100° C.

10 Gm. samples of this calcium soil were treated with different quantities of Na_2CO_3 with a view to introduce different amounts of exchangeable sodium. These samples differing only in their S-value were tested for permeability in percolation tubes by observing the descent of the level of water per hour. The percolation rate was also calculated by the above formula. The value of S was obtained by determining the exchangeable calcium in each mixture. A typical result of these experiments is given in Table I.

TABLE I

Soil No. 10, Clay: 26·6 per cent.
Base exchange capacity: 16·6 m.e.
$a = 0{\cdot}154$, $b = 0{\cdot}032$

No.	Na_2CO_3 added	S	Y observed (cm./hour)	Y calculated
1	1%	20·5	(80×10^{-3})	(80×10^{-3})
2	2%	29·8	60 ,,	58·8 ,,
3	3%	43·4	40 ,,	38·0 ,,
4	4%	63·2	20 ,,	20·07 ,,
5	5%	78·7	12 ,,	12·18 ,,
6	6%	83·2	10 ,,	10·53 ,,
7	7%	91·7	(8 ,,)	(8·0 ,,)
8	10%	95·8	8 ,,	7·02 ,,

We have examined six natural soils which were treated as explained above and five artificially prepared mixtures of clay and sand and found that the equation:

$$Y = ae^{-b}S$$

holds good in every case.

The constants 'a' and 'b' are arbitrary and vary from soil to soil. An attempt has been made to correlate them with some characteristic properties of the soil. Table II shows the relation between the base exchange capacity of six soils and the constant 'b'.

TABLE II

Soil No.	Base exch. capacity (B)	b	b/B
12	14·8	·0283	$1{\cdot}9\times10^{-3}$
5	20·5	·0400	2·0 ,,
10	16·6	·0320	1·9 ,,
3	13·4	·0250	1·8 ,,
13	9·88	·0180	1·8 ,,
15	7·11	·0120	1·8 ,,

It will be seen from the last column that the ratio b/B is very nearly a constant, and hence the arbitrary constant 'b' in Harris equation is directly related to the base-exchange capacity of the soil.

The constant 'a' in the above equation may probably be interpreted in terms of another known characteristic of the soil—the clay content. It is found that 'a' is inversely proportional to the logarithm of the clay content. The relevant data are given in Table III.

TABLE III

Soil No.	Clay content (c)	a	$a \log c$
12	27·44%	0·136	0·1967
5	27·6	0·136	0·1967
10	26·6	0·154	0·2290
3	22·43	0·083	0·1430
13	21·85	0·178	0·2380
15	26·32	0·138	0·1990

The small variations of values in the last column might be due to the presence of secondary particles. To clear this point experiments were carried out with artificial mixtures of pure sand and the colloidal part of the soil. The results obtained are summarised in Table IV.

TABLE IV

Soil No.	B	Clay % (c)	Sand %	b	a	b/B	$a \log c$
1	31·8	100	0	·057	·129	$1·8 \times 10^{-3}$	·2580
2	15·9	50	50	·028	·148	1·8 ,,	·2500
3	9·54	30	70	·018	·177	1·9 ,,	·2632
4	7·95	25	75	·016	·180	1·8 ,,	·2492
5	6·36	20	80	·012	·195	1·9 ,,	·2542

The significance of the values in the last two columns will be easily understood. To make certain we carried out further experiments with pure clay prepared from three different soils in which B was different, and also with artificial mixtures in which B was kept constant and the clay content varied. The results obtained confirm the conclusion already arrived at.

If we now substitute the new values for 'a' and 'b' in equation (1) we obtain the expression:

$$Y = \frac{k_1}{\log c} \cdot e^{-k_2 BS}$$

And since

$$S = \frac{(Na^+)}{B} \times 100, \text{ the final equation is}$$

$$Y = \frac{k_1}{\log c} \cdot e^{-k_2'(Na^+)}$$

where k_1 has the value round about 0·25, and k_2' is almost exactly equal to 0·18.

This apparently very satisfactory equation fails, however, in the two limiting cases, namely in pure calcium, and pure sodium, soils. The problem is further being studied.

Lucknow University, K. P. SHUKLA.
February 15, 1943. M. R. NAYAR.

[1] Harris, A. E., *Soil Sci.*, 1931, **32**, 435.

INFLUENCE OF Na^+, NH_4^+ AND K^+ IONS ON THE PERMEABILITY OF CALCIUM SOILS

AMONG the various factors which determine the porosity of soils to water, the specific effect of adsorbed ions is often one of the most important. It is well known that alkali soils, in which exchangeable sodium predominates among the exchangeable bases, are impervious to water, while normal soils, which are mostly calcium soils, are quite porous. Generally speaking, soils saturated with monovalent cations allow water to filter through less readily than those saturated with divalent ones.

Here an attempt has been made to compare the effect of three alkali cations on soil permeability when increasing amounts of them replace exchangeable calcium in a pure calcium saturated soil. Pure soils saturated with calcium, sodium, ammonium and potassium were prepared by leaching first with N/20 HCl and then by a litre of the normal solution of respective chlorides. Free salts were removed by washing first with water and finally with alcohol. Soil samples containing an exchangeable alkali cation and exchangeable calcium were prepared by mixing them in desired proportion. These samples were then subjected to comparative permeability tests. The second, fourth and sixth columns of the table below give the rates of percolation of water.

The rates of percolation were also calculated by means of an empirical relation first enunciated by A. E. Harris[1] in the case of an alkali soil. This equation is:

$$Y = ae^{-b} S$$

where Y is the rate of percolation; S is the percentage saturation with respect to the alkali ion, that is

$$S = \frac{\text{Amount of alkali cation}}{\text{Base-exchange capacity}} \times 100,$$

a and b are constants.

The calculated values in the three cases are given in the third, fifth and seventh columns of the table, while the equations which fit best with observed values are given in the last row.

S.	Rates of percolation in inch per hour					
	Na^+		NH_4^+		K^+	
	observed	calculated	observed	calculated	observed	calculated
(1)	(2)	(3)	(4)	(5)	(6)	(7)
0	·190	·138	·190	·172	·190	·180
10	·09	·090	·133	·133	·171	·169
20	·054	·054	·100	·103	·158	·158
30	·033	·033	·079	·080	·144	·148
40	·021	·024	·063	·062	·138	·138
50	·013	·014	·044	·048	·129	·129
60	·008	·009	·038	·037	·117	·121
70	·006	·006	·029	·029	·113	·113
80	·004	·004	·023	·022	·106	·103
90	·006	·002	·017	·017	·100	·099
100	·006	·002	·012	·013	·091	·093
Equations which fit best with observed values	$Y = 0·138e^{-·044s}$		$Y = 0·172e^{-·0227s}$		$Y = 0·180e^{-·0067s}$	

It will be noted that in general the exponential relation between Y and S is satisfied. When $S = 0$ the soil complex is wholly saturated with exchangeable calcium for which the observed value is 0·19 inch per hour; but the calculated values (values of the constant '*a*') are far less and they increase from sodium to potassium.

The constant '*a*' seems to increase with the atomic weight while the constant '*b*' decreases in the same order.

The effect of the three ions in decreasing the rate of percolation in calcium soil thus is as:

$$Na^+ > NH_4^+ > K^+$$

which is also the order of increasing ionic radius.

Lucknow University, M. R. NAYAR.
February 27, 1943. K. P. SHUKLA.

1. Harris, A. E., *Soil Sci.*, 1931, **32**, 435.

INCLINED EXTINCTION IN THE HYPERSTHENES OF CHARNOCKITES

DR. P. K. GHOSH has summarised the views put forward to explain oblique extinction observed in the hypersthenes of Charnockites, and inclines to the view of K. K. Sen Gupta that the oblique extinction is due to the persistence of original amphibolic cleavages in the hypersthenes.[1]

Mr. M. S. Sadasiviah, Lecturer in Geology, Central College, has made detailed statistical studies of oblique extinction observed in about a 100 mineral grains of the hypersthenes occurring in the Charnockites of Halagur. Three lines of statistical investigation have been instituted to study the oblique extinction; (1) the pleochroic scheme of the several mineral grains, (2) the optic figures and (3) the calculated angles with the aid of certain Crystallo-optic formulæ.

The pleochroic scheme of the hypersthene of Halagur is X = pink, Y = brownish-yellow and Z = bluish-green. The principal sections of the mineral grains have, therefore, the pleochroic scheme, XZ = pink to bluish-green, XY=pink to brownish-yellow and YZ=brownish-yellow to bluish-green. XZ sections give optic normal figures, YZ give BX_{ac} figures, and XY, BX_0 figures. XZ and YZ sections give straight extinction, but, when the pleochroic shades depart from this scheme, oblique extinction results, the angles varying from 0° to a maximum of 26°, the maximum angle being observed on a section giving an uncentred optic axis figure. Since the optic orientation of hypersthene is XZ//010, and X is perpendicular to 100, the sections giving optic axis figures (centred or uncentred) are either domes or pyramids. Since hypersthenes, like other Orthorhombic minerals with prismatic cleavages, give straight extinction in the 010-100 and 001-010 zones, and oblique extinction in all *other* zones,[2] theoretical extinction angles were calculated for the 001-100 and 001-010 zones with the aid of the Rosenbusch-Wulfing formula.[3]

$$\text{Tan } 2\gamma = \frac{\cos\phi\,[\tan(V+\Gamma) - \tan(\Gamma - V)]}{1 - \cos^2\phi\,\tan(V+\Gamma).\,\tan(\Gamma - V)}.$$

The theoretical angles were calculated for the acute prismatic angle both of pyroxenic and amphibolic cleavages.

Inclination of face to (001) = ϕ	$\gamma = 45°\ 52'$ Pyroxene Cl.	$\gamma = 28°$ Amphibole Cl.
0°	45° 52′	28°
10°	45° 45′	27° 47½′
20°	45° 45′	27° 47′
30°	43° 4½′	25° 58′
40°	41° 44½′	24° 10′
50°	36° 53½′	21° 36′
60°	31° 46′	18° 1¼′
70°	24° 22′	13° 11½
80°	13° 45½′	7° 3′
90°	0°	0°

Since the maximum extinction angle observed in the hypersthene of Halagur is 26° and the average angles are 11°-13°, the maximum extinction observed should be on a dome face having an inclination of 70° to 001 (if the cleavage observed is pyroxenic) or a dome face inclined to 001 at 30° (if the cleavage were amphibolic). The indices of these hypothetical faces were calculated by Neumann's Gnomonic Method[4] and were found to be (011), (101), (041) and (401). But neither of these domes occur in amblystegite, the variety of hypersthene observed in Charnockites.

Therefore resort was made to the Ferro-Brandavo formula for calculating extinction angles on the pyramids (111) and (232), occurring in amblystegite (Fig. 1-Stereographic Projection with facial poles and their calculated extinction angles). The Ferro-Brandavo formula is,

$$\text{Cot } 2\gamma = \frac{(\cos\mu\cos\nu - \sin\mu\sin\nu\cos^2\upsilon) + (\sin\mu\sin\nu)\sin^2\phi}{[\cos\upsilon\sin(\mu+\nu)]\cos\phi - [\sin\nu\sin(\mu-\nu)]\sin\phi}$$

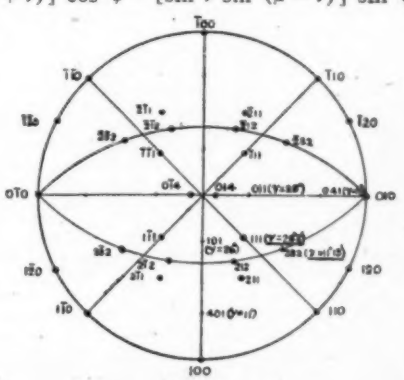


FIG. 1
Calculated Extinction Angles (γ) in Amblystegite

The value of 2 V (optic axial angle) required in this calculation was determined on the Federov's Stage by the method of direct measurement of the optic axial angle by sharp extinction at the emergence of the optic axes, in the 45° position.[5] The value of 2 V for the Halagur hypersthene is 54° 42′. The extinction angles calculated by the Ferro-Brandavo formula for (111) and (232) are 28° 3′ and 11° 15′, assuming the cleavages to be pyroxenic. Since the calculated values agree closely with the observed values in hypersthenes of Halagur (26° and 11°-13°), it is hereby inferred that the oblique extinction observed in the hypersthenes are on the *pyramidal* faces and that the cleavages are pyroxenic.

Dept. of Geology,
Central College,
University of Mysore,
Bangalore, P. R. J. NAIDU.
May 7, 1943.

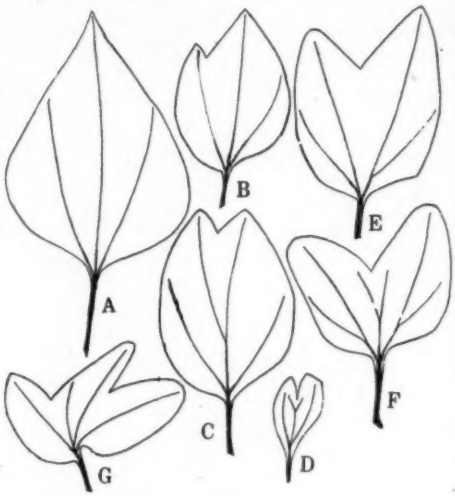
1. G. S. I., *Professional Paper, No.* 15, 1941, p. 10. 2. Winchell, A. N., *Text-Book of Optical Mineralogy*, 1931, p. 167. 3. Johannsen, A., *Manual of Petrographic Methods*, 1918, p. 402. 4. Barker, T. V., *Graphical and Tabular Methods in Crystallography*, 1922, p. 36. 5. Johannsen, A., *Op. cit.*, p. 493.

ANOMALOUS LEAVES OF *HELLANTHUS ANNUUS* LINN. N. O. COMPOSITÆ

THE abnormal bilobed opposite leaves (Figs. B-G) differ from the normal leaf (Fig. A) in shape, size and venation. Out of 323 seedlings only seven had such abnormal leaves, one on each seedling. There was one trilobed leaf; others were bilobed. It was observed that leaving aside the cotyledons third, fourth, fifth, sixth and seventh leaves showed abnormality of one of these types. Either one leaf or both the leaves at a node was found to be abnormal.

The arrangement of the leaves was at first opposite and decussate but later it became alternate. It has been observed that in a plant growing under normal conditions, the change of phyllotaxy begins after about four pairs of opposite leaves have appeared. Out of the seven seedlings described above, four were of that type. The fifth one had the change of phyllotaxy after the first pair of opposite leaves had appeared. In the case of the sixth one alternate leaf intervened between the first and the second pair of opposite leaves. The last one did not agree with those already described. It had two leaves at a node, one at right angles to the other. These intervened with the alternate leaf of the second and the fourth, and the fourth and the sixth nodes.

Similar instances are recorded by Masters,[1] Worsdell,[2] Sabnis,[3] Singh,[4] and Singh and Sinha.[5] The abnormalities recorded in this plant are the presence of three cotyledons instead of normal two,[6] insertion of leaves and head,[7] leafy growth in the centre of the inflorescence and fasciation of capitula.[8]



The leaves described may be taken as the case of fission of foliar organs. According to the view expressed by Masters[1] "fission is due perhaps as much to the absence or relatively small proportion of cellular as compared with vascular tissue". This view is further supported by Goebel,[9] who has shown that there is a definite relationship between the shape and form of the leaf and its vascular distribution or venation. Hence the present abnormal leaves may be due to the plan of arrangement of the venation.

From the study of venation, phyllotaxy and absence of any sign of union in any part of the leaf, the leaves described may not be taken as the case of fasciation.

Bahauddin College,
Junagadh, G. A. KAPADIA.
April 1, 1943.

1. Masters, M. T., "Vegetable Teratology," 1869. 2. Worsdell, W. C., "The Principles of Plant Teratology, 1915, **1**. 3. Sabnis, T. S., *Journ. Ind. Bot. Soc.*, 1931, **10**, 22 4. Singh, T. C. N., *Ibid.*, 1930, **9**, 248. —, *Ibid.*, 1931, **10**, p. 135. —, *Ibid.*, 1935, **14**, p. 313. 5. Singh, T. C. N., and Sinha, B. N., *Ibid.*, 1928, **7**, p. 99. 6. Kapadia, G. A., *Journ. Uni. Bom.*, 1940, **8**, p. 125. 7. Parandikar, S. A., *Current Science*, 1933, **2**, p. 243. 8. Singh, T. C. N., *Proceedings of the 18th Indian Science Congress*, 1931, pp. 270–71. 9. Goebel, K., *Organography of Plants*, Part II, 1906, p. 338.

ON TERATOLOGICAL FEATURES IN SOME PLANTS

TERATOLOGICAL features are often taken as the basis for explaining various problems concerning the evolution of the floral parts. Many of the modifications are construed to be reversions to ancestral types indicating the primitive state. Many flowers of *Cucurbita maxima* collected by the author were found to be virescent. In the centre of the flower leafy structures with stalk and blade developed due to proliferation (Fig. 1) or the continued growth of the pedicel. Similar abnormal features have been noticed by Kausik (1938) in *Trichosanthes anguina*, another member of the *Cucurbitaceæ*. In the male flowers the anthers which are usually synantherous had separated. The connate condition disappears and this phenomenon termed dialysis seemed to be a common feature in the malformed flowers.

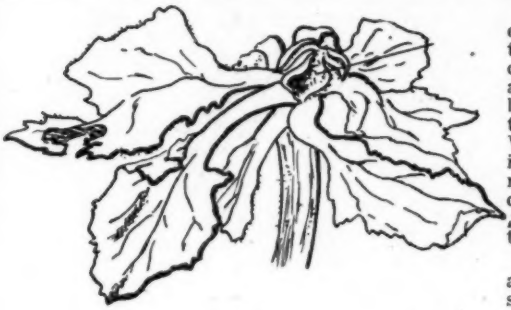


FIG. 1
Abnormal flower of *Cucurbita maxima* Linn.

FIG. 2
Shoot of *Flacourtia sepiaria* Roxb. showing fasciation

The flowers of *Grangea madaraspatanensis* Poir are normally bright yellow. In many cases the floral parts become foliaceous and in place of the ray and disc florets small leaves were observed in the capitulum. This phyllody of the florets was accompanied by virescence of the petals, with the result that no patch of yellow colour could be observed in any part of the inflorescence.

Fasciation of stem was noticed in the case of *Flacourtia sepiaria* Roxb. The plant is a thorny shrub growing in waste places. Some of the branches had lost their prestine form and had assumed a flattened condition. The branchlets had fused and this was manifest by the position of the axillary spines (Fig. 2). Worsdell (1915) is of opinion that fasciation is the result of superabundant nutrition. Large number of buds that arise in close proximity develop simultaneously exerting mechanical pressure on each other, and become "grafted" together to form a single shoot.

Thanks are due to Dr. L. N. Rao for guidance and to Mr. M. J. Thirumalachar for helpful suggestions.

Dept. of Botany,
Central College,
Bangalore, K. S. GOPALAKRISHNAN.
May 10, 1943.

1. Kausik, S. B., *New Phytologist*, 1938, **37**, 396-408.
2. Worsdell, W. C., 1915, "Principles of Plant Teratology."

THE GENUS *DRAPARNALDIOPSIS*[1] SMITH AND KLYVER

THIS genus was established in 1929 in America on the discovery of an alga by Smith and Klyver, who named it *Draparnaldiopsis alpinis*.[1] Besides this American species, the only other species, so far recorded, is *Draparnaldiopsis indica*,[2] which Professor Y. Bharadwaja described from Benares. The genus shows great specialization in its somatic organization among the Chætophoroales, of which it is one of the important members. It is on this account that Professor F. E. Fritsch, F.R.S., of the London University, selected *D. indica* Bharadwaja for the frontispiece of his classical book *Structure and Reproduction of the Algæ*.[3] Only the morphology of the two species was described, and the study of the reproduction and cytology was not attempted. The present writer has, therefore, made a detailed investigation, both in natural and artificial cultures, of the various stages in the life-history of the local species, *Draparnaldiopsis indica* Bharadwaja.

The alga possesses well-defined asexual and sexual methods of reproduction, effected by

means of motile swarmers. The quadri-flagellate macrozoospores, the quadri- and bi-flagellate microzoospores, and the biflagellate gametes have been recognised. The first two are invariably asexual in nature, whereas the more or less similar gametes from different plants fuse in pairs to form zygospores, which germinate directly to give rise to new plants. The reproduction of this plant is, therefore, similar to that of *Ulothrix zonata* Kützing[3] and *Fritschiella tuberosa* Iyengar.[4] The ecological factors determining swarmer-formation have also been studied. A complete account of the investigations in this respect has recently been published in the *New Phytologist*.[5]

A further study of the cytology of the alga is under investigation, but the data so far obtained show that there are two types of plants,—the asexual diploid plants possessing eight chromosomes and the haploid sexual ones bearing four chromosomes. The two types of plants are exactly similar to each other in external features and, therefore, *D. indica* Bharadwaja possesses an isomorphic alternation of generations.

Department of Botany, RAMA NAGINA SINGH.
Benares Hindu University,
March 10, 1943.

1. Smith, G. M., and Klyver, F. D., *Trans. Amer. Microsc. Soc.*, 1929, **48**, 196 *et seq.* 2. Bharadwaja, Y., *New Phytologist*, 1933, **32**, 1 *et seq.* 3. Fritsch, F. E., *Structure and Reproduction of Algæ*, Cambridge Uuiversity Press, 1935, p. 203. 4. Singh, R. N., *New Phytologist*, 1941, **40**, 170 *et seq.* 5. Singh, R. N., *Ibid.*, 1942, **41**, 262 *et seq.*

THE EXTERNAL GENITALIA OF *ALEURODIDAE*

IN a previous note[1] published in this journal attention was drawn to the uncommon variety exhibited by the antennæ among the whiteflies. The external genitalia also present a certain amount of diversity of structure, which should provide a reasonable basis for a systematic revision of the group, based on the characters of the adult. Numerous morphologists like Muir,[2] Snodgross,[3] etc., have emphasized the importance of genitalia in the generic and specific determinations of several groups of insects; and the whiteflies appear to conform to other insects in this respect. The external genitalia of a male as a rule consist of a pair of parameres broad at the base, tapering and incurved distally. The aedeagus is also wider at the base, tapering gradually to its free end. A glance at the diagram will show the variability exhibited by the parameres as well as the aedeagus in some representative examples. *Dialeurodes trilobitoides* Q and B[4] (Fig. 1 *b*) seems to have an unmodified aedeagus which tapers gradually to its tip. In *Dialeurodes eugeniæ* Maskell near the distal end of the aedeagus there is a short cylindrical outgrowth (Fig. 1 *a*). *Taiwanaleyrodes indicus* Singh has a small conical protuberance close to the distal end (Fig. 1 *g*) and in *Aleurotuberculatus psidii* Singh there is a four-lobed outgrowth in the same position (Fig. 1 *f*). In *Aleurotuberculatus minuta* Singh and *Trialeurodes bicolor* Singh the tip of the aedeagus is curved and hook-shaped (Fig. 1 *d* and *e*). The aedeagus of *Aleurotulus maculata* Singh is bulbous and swollen distally with a fine jet at the end (Fig. 1 *h*). Lastly the aedeagus of *Dialeurodes glomerata* Singh is forked distally (Fig. 1 *c*). These characteristic features of the genitalia appear to be constant in the several individuals examined.

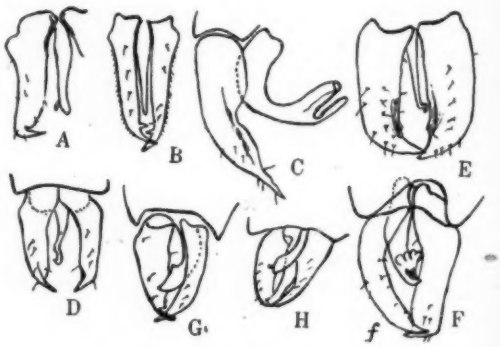


FIG. 1

The functional significance of this variability is difficult to comprehend. The parameres are employed to open out the valves of the ovipositor at the time of copulation, and the aedeagus for the transference of the sperms, and the variability of these structures may have some relation to the corresponding structures on the abdomen of the female; but no such variations have been noticed in the females which have been examined so far. Despite their unknown function, the systematic importance of these structures is obvious.

Dept. of Zoology,
College of Science,
Nagpur, KARAM SINGH.
March 18, 1943.

1. *Curr. Sci.*, 1936, **5**, 304. 2. *Pr. Hawaii ent. soc. Honolulu*, 1916, **3**. 3. Smithson, *misc. coll. Washington*, 1931, **96**. 4. *Mem. Dept. Agric.*, 1931, **12**, 28.

REVIEWS

Short-wave Wireless Communication including Ultra Short-waves. By A. W. Ladner and C. R. Stoner. (Chapman and Hall Ltd., London), 1942. Pp. xvi + 573. Fourth Edition. Price 35*sh.* net.

This latest edition of Ladner and Stoner's well-known book needs little introduction to students of Wireless. The first edition of the book appeared in 1932 and the fact that in the course of ten years, as many as four editions have come out with two or three reprintings for each edition, shows clearly the well-deserved popularity of this book. This fourth and "War-time" edition of the book is very welcome indeed as it contains a great deal of new material, though, as the authors themselves regret, "the exigencies of the times have prevented references to many new and interesting developments of short-wave and in particular ultra short-wave working".

The subject-matter of the various chapters is modified and a good amount of additional information given. Also, two new chapters have been added, namely, one on "Electron Oscillators" and the other on "High Frequency Therapeutic Apparatus", while two of the chapters in the earlier edition—those on "High Frequency Transmitting Apparatus" and "Ultra Short-waves" have been cut out and the matter contained therein have been included in other chapters. Thus, the behaviour of ultra short-waves instead of being treated separately, is considered side by side with short-waves as there are many features common to both. Another feature of the new volume is the rearrangement of the chapter sequence.

The first two chapters are more or less introductory in nature and deal with general items such as history of wireless, etc. The third chapter on "Modulation of High Frequency Waves" contains a lengthier elucidation of the principles of frequency and phase modulation than in the earlier edition. In the fourth and fifth chapters, the propagation of short- and ultra short-waves over short distances (direct ray) and through the ionosphere (indirect ray) are considered. Here some of the more elementary ideas on wave propagation have been cut out and a more detailed description of the ionosphere included. A notable feature is the mention—though it is very brief—of Contour Charts for estimating sky-wave field intensities, illustrated later in the appendix with practical examples.

The next two chapters are on aerials and aerial arrays. Here, in addition to other things, the properties of a quarter wave line as an impedance matching device as well as the use of the reactance transformer for the same purpose, are discussed and illustrated with practical examples. Mention is also made of feeder attenuation measurements, effect of insulator spacing on feeder attenuation and the velocity slip in feeders with a useful table for evaluating this last quantity for various typical feeders. In addition, a brief account is given of different types of feeders such as the four wire feeder system, feeders for television purposes and the properties of dielectric wave guides. In the chapter on Aerial Arrays, a brief description is given of a very important novel development due to the Marconi Company, for using Rhombic Aerials for transmitting purposes with efficiencies as high as 90 per cent. as compared with the usual low figure of about 40 to 50 per cent. for this type of aerial. This improvement is achieved by using a number of Rhombic antennæ connected in series, parallel or series-parallel arrays.

The rest of the chapters, namely, ninth to eighteenth, are more or less devoted to high frequency transmitting and receiving circuits. The chapter on "Power Amplifiers" gives useful information on the design of tank and output circuits and mention is made of the 'Inverted Amplifier' system developed by the Standard Telephone Company in their short-wave transmitters installed at the B.B.C. Elsewhere, in the book the quartz crystal oscillator is described in great detail as also the various types of recently developed electron oscillators such as those using the Electron Beam Deflection and the velocity modulated beam principles as well as the 'Klystron' Oscillator developed by R. H. and S. F. Varian.

Other additional information incorporated in the book includes the description of various recently developed systems of modulation such as the series modulation cathode follower and the cathode modulation systems as well as a very interesting description of one of the 100 K.W. Short-wave Transmitters installed at the B.B.C. The chapter on "Commercial Receivers" discusses in detail, among other things, the performance specifications of receivers and emphasis has been rightly placed on the fact that the overall gain of a receiver should be specified with reference to the *signal/noise ratio* as the inherent noise due to the shot and thermal agitation effects, sets a limit to the useful gain of a receiver.

The book concludes with a very fascinating chapter on High Frequency Therapeutic equipment.

While the additional information enumerated above is to be welcomed, it is to be noted at the same time that the authors have made only brief references to most of them. Though, in a book of this nature, it is inevitable if the size of the book is not to become unduly large, yet one cannot but feel that at least in a few places, a greater amount of detail should have been given, especially in those cases where published information is scanty or nil. Thus, in the case of the transmitting type of Rhombic Arrays developed by the Marconi Company, a detailed description of the design methods adopted should have been of very considerable value. Similarly, in the case of the Contour Charts for estimating sky-wave field strengths, mention should have been made of the method adopted in deriving these

charts. In the same way, a more detailed analysis could have been given of the attempted *quantitative* methods, if any, for correlating sunspot activity with F_2 layer critical frequencies and also the methods adopted for forecasting the latter quantity for various months and *latitudes* and for various distances.

There are practically no mistakes in the text except on page 231, line 4, where 'Principal' should be read as 'Principle'.

The new edition, as its predecessors, gives a number of very useful and recent references and there is no doubt that the book will be highly welcomed and valued by those interested in "Wireless".

K. V.

Science for the Prosecution. By Julius Grant, M.Sc., Ph.D., F.I.C. (Chapman and Hall, Ltd., London,) Pp. 302. Price 15*sh.* nett.

It is refreshing to turn to the part played by Science in the investigation of Crime at a time when what is uppermost in one's mind is the part it has played in the prosecution of wars. The book is not meant to be a treatise for reference by persons engaged in scientific work connected with unravelling of crimes nor is it meant merely to provide material for spending a few pleasant hours reading about the sensational discoveries resulting from the application of science to criminal investigation. The book strikes a happy mean between providing an adequate theoretical treatment to enable the reader to follow the principles on which such scientific work is based, and a narration of actual cases to the investigation of which the scientific method has made such valuable contribution. The book opens with a general chapter on the scientific approach to crime in which the author makes a powerful plea for the establishment of an independent medico-legal institute. The application of science to criminal investigation is then classified as consisting of (1) optical methods; (2) chemical methods and (3) blood group tests. The book closes with a chapter on Psychology and Crime.

The author himself is a distinguished worker in the field of fluorescence analysis and brings his long experience to bear upon his treatment of the subject. The brilliant work of Mitchell in regard to the age and classification of paper and writing materials, the work of Carter and Pollard on classification of paper and that of Professor Laurie in regard to finding the ages of works of art is referred to.

The cases mentioned make interesting reading. Questions pertaining to food adulteration are dealt with and it is indicated how in England the legislative measures "now constitute a true chapter of public food safety". The book will be altogether invaluable not only to scientific workers in the criminological field and to the Police Services, but also to the legal profession who can get an extremely adequate idea of the background of scientific work bearing upon criminal investigation.

One word may be said about the title of the book. The book is no doubt named *Science for the Prosecution* and in the race between the criminal and the forces of law and order there can be no doubt that scientific knowledge is an invaluable weapon in the hands with the latter. But in a country like India where, owing to various circumstances, scientific evidence adduced in courts is mostly on the prosecution side, the knowledge and guidance provided by the book of this kind will prove invaluable to the defence also.

A list of specialised treatises pertaining to the field increases the value of the book and greatly facilitates pursuit of any particular branch of scientific criminal investigation.

N. S. R.

High Frequency Thermionic Tubes. By A. F. Harvey, with a Foreword by Dr. E. B. Moullin. (Chapman & Hall Ltd., London), 1943. Pp. 235. Price 18*sh.* net.

The last few years have witnessed a phenomenal increase of interest in the application of ultra high frequencies to practical services such as television, frequency modulation, etc. This has stimulated invention, development and refinement of electronic tubes and circuits suitable for the several applications, of which the book under review gives a short account in six chapters.

After a brief general introduction in Chapter I on the function of electronic tubes as rectifiers, amplifiers, etc., and their feed-back characteristics, the author discusses in Chapter II the influence of the frequency of operation on the tube properties such as input and output impedances and mutual counductance. The limitation in their performance imposed by the finite transit time of electrons at frequencies above 20 megacycles per second and the consequent refinements introduced in tubes of the conventional types, are next discussed and various commercial receiving and transmitting tubes exhibiting a good performance beyond 20 mc./s. are described and illustrated. These include a comprehensive range, from the well-known 'acorn' type of miniature receiving tubes to the water-cooled transmitting tube RCA 888 giving an output of 300 watts at 200 mc./s. The latter half of the same chapter is very usefully devoted to the measurements of tube parameters at U.H.F. by the method developed by M. J. O. Strutt.

This effect of electron inertia has made pospible the production of U.H.F. by an unconventional use of existing tubes or by the invention of tubes utilising different principles altogether. To the former category belongs the retarding field or positive grid generator discovered by Barkhausen and Kurz which is dealt with in some detail in the first half of Chapter III; the second half describes "the use of positive ion tubes as a means of studying conveniently effects which are appreciable with electrons only at frequencies so high as to preclude accurate measurements."

The second category includes the magnetron tube described in all its aspects in chapters IV and V which comprise a little under half of the book. Here the author has collected and organised in a thorough and well-balanced manner the fundamental and practical information regarding the magnetron such as the cut-off characteristics, oscillations in the

dynatron regime, the resonance regime and the electronic regime. This is only appropriate since for frequencies higher than 600 mc./s. the magnetron provides larger outputs than those so far reported (except by Klystron described later) and has been used at frequencies upto 30,000 mc./s. ($\lambda = 1$ cm.) a value well above that reported for any vacuum tube. In view of its comparatively simple electrode structure the magnetron would seem to lend itself easily to theoretical treatment, but it has always behaved in an unexpected manner and defied all explanations offered so far.

The demand for larger power outputs at U.H.F. resulted in 1939 in the development of the Klystron based on principles of electric resonators and velocity modulation of cathode-ray stream which form the subject-matter of the first part of Chapter VI. The reviewer cannot help feeling that it would have been more helpful for an understanding of these principles had the author devoted more space to develop and discuss these at a greater length instead of giving rather concise accounts of various publications. In the latter part of this chapter a readable account is given of the work of Barrow, Brillouin, Southworth and others on wave-guides and horn radiators for providing directional beams at U.H.F.

An important feature of the book is the bibliography at the end of each chapter, the total number of references being 517; a welcome change, in the opinion of the reviewer, is the use throughout of the word 'tube' in place of 'valve' in an English publication. The brevity of Chapter I has not contributed to the clarity of the statements with regard to the feed-back principle.

It will be sometime before we will be in a position to appraise the stimulus given to this vital subject by the present war conditions. We have heard of the Radio Locator and the Radar. In the meantime Dr. Harvey has done a great service by making an exhaustive and disinterested survey of a field in which developments have been so rapid that critical judgment must necessarily be held in abeyance for the present.

The volume contributes an important book of reference for every worker in this most fascinating branch of electron physics and communication.

N. B. Bhatt.

High Speed Diesel Engines. By A. W. Judge. Fourth Edition. Revised and Enlarged. (Messrs. Chapman and Hall, London), 1941. Pp. viii + 535. Price 25*sh.* net.

This book on "High Speed Diesel Engines" by A. W. Judge has run through another edition now, the fourth, and the author has taken advantage of this to make the book more up to date. This has resulted in an addition of 100 pages of more matter and a large number of diagrams. In recent years this book has come to be regarded as a text-book covering the entire field of the compression Ignition Engine in all its various applications and its value has been enhanced by these additions. The results of recent researches on fuel injection systems, the methods of cooling the nozzle and protecting it and recent methods of engine governing have been incorporated. New types of automobile and aircraft engines and two cycle engines have been added. Under engines of the Railway type details have been given of the latest railcar and locomotive types of C.I. engines and an account of the performance of the railcar or locomotive to which they are fitted has been given. The subjects of supercharging and altitude performance and the ratings of fuels have been considerably enlarged. One other noteworthy feature of the book is that some of the accounts of earlier engines and the fuel injection systems which are now obsolete, have been retained so as to make them available to the student and designer.

The treatment is on the whole excellent considered from all aspects, theoretical, practical or descriptive.

Lessons in Elementary Analysis. By G. S. Mahajani. Third Edition. (Aryabhushana Press, Poona), 1942. Pp. viii + 298. Price Rs. 6-4-0.

This well-known book by Prof. Mahajani, which has now run into a third edition, is a very well-thought-out one, and forms an excellent introduction to the subject of elementary analysis as taught in Indian colleges. The standard reached may perhaps be correctly described as lying between the Pass and Honours courses in the several universities. We are glad to note that several deficiencies that occurred in the previous edition (like Balakram's problem) have been omitted in the latest edition. The other changes like the proof of the second mean value theorem on integrals, the note on Frullani's integrals, a more careful treatment of uniform convergence, and the addition of a larger number of exercises have all enhanced the value of the book.

The chief merits of Prof. Mahajani's book are the extreme clarity and coherence achieved in the development of the subject. The author has modelled his book on that excellent "Cours d' Analyse" of De la Vallée Poussin, and succeeded admirably in imbibing its spirit, and following its methods. But this book is no mere copy of Vallée Poussin's, for the field and range of topics are different as also the outlook, and a lot of care, ingenuity and discretion have been used in writing a book with limited objectives but of the high standard indicated by Vallée Poussin's course of analysis. Special mention might be made of the excellent treatment of mean value theorems, Taylor's theorem and uniform convergence. The several notes and exercises have been carefully chosen and serve to illustrate clearly the difficult points involved in the immediately preceding theory. There is plenty of rigour but not such as to spoil the clarity of presentation at the elementary stage, nor is the book made too easy at the cost of rigour. A fine balance has been achieved, and the result is an extremely valuable elementary introduction to analysis.

There are, however, one or two points on which improvement is desirable. The introduction to integration through the notion of an area appears incongruous in a book which

is professedly rigorous. The area under a curve has no being apart from its definition as an integral, for, in Mathematics all being is of a logical character and hence area as a geometric intuition cannot be taken for granted. It would have been of great value to the student if a short introduction to the theory of integral had been appended, and also the distinction between primitive and integral (Cauchy or Riemann) dealt with more exhaustively. Again Ex. 3 on p. 83 should not have found a place in the book; it is characteristic of loosely written text-books which pay no attention to rigour.

These blemishes apart, we have no hesitation in recommending this book as an excellent introduction to elementary analysis.

K. S. K. AND B. S. M.

Wave-Mechanics. (Sukraj Rai Readership Lectures, 1939-40.) By V. V. Narlikar, (Patna University), 1942. Pp. vii + 160.

This account of wave-mechanics is based on a series of eight lectures delivered by the author, and presents a birds'-eye-view of the development of the subject and its broad principles. The topics treated are as follows:— classical mechanics, theories of Einstein and Bohr, Schrödinger's theory, transformation theory of Dirac, relativistic theory of the electron, theory of radiation and nuclear forces. The first seven chapters are of an expository nature while the remaining two chapters constitute a sort of report on the topics dealt with under them. The earlier expository part is in the historical order of development, *viz.*, classical mechanics, old quantum theory and the new quantum mechanics, and such a development has its own advantages as well as disadvantages. A historical treatment would perhaps have been inevitable in the earlier days of quantum mechanics when the theory itself was in a flux, but now that we have a sort of a satisfactory finished product it would be hard to justify such a treatment. In the three chapters on Waves and Particles, Matrices and Waves, and States and Observables, there is a repetition of ideas which has the danger of hiding the essential principles of wave mechanics under the mass of a number of alternative but equivalent mathematical representations. The distinction between non-relativistic and relativistic quantum mechanics is nowhere presented clearly in the book. Thus the postulates of the Dirac theory of the electron as given on p. 104 are definitely defective. Also the mention of the positron on p. 61 in company with a number of other collision problems which can be treated non-relativistically serves to give the wrong notion that the theory of the positron is also non-relativistic.

As the author himself admits the treatment in many places is "too sketchy and scrappy". As examples we might mention the following:—

(*i*) The treatment of group theory and group representations on pp. 148-52 appears superfluous inasmuch as no attempt is made to apply it even to a single problem. After giving this account of four pages in a book on Wave Mechanics it appears like an anti-climax to say at the end that "one of the most important applications of groups is in the study of crystallography".

(*ii*) The conclusion that the highest atomic number is 92 from the bare remark (p. 115) that "out of 136 possible rotations only 91 left the interaction term of two electrons unchanged" savours of Eddington's epistemological considerations, and can hardly be considered a proof.

(*iii*) The remarks (p. 123) on the nature of light are rather loosely worded. To the question "What is light, waves or particles?" the author returns the answer that it is neither. The correct answer, however, is that it is both since, according to the principle of complementarity, a complete description of natural phenomena may require the use of two points of view mutually contradictory. As regards the definition of light the author remarks (p. 124), "Those who know the mathematical theory can do without the definition which is not precise enough. Those who do not understand the theory will not be enlightened by the definition because it is too technical" This looks like unnecessary mystification, and gives an altogether wrong idea of the quantum theory of radiation.

(*iv*) The phrase "inside the electron" appears in many places in the book. This is perhaps a picturesque way of describing the neighbourhood of the nucleus, but it is rather loose terminology since it suggests that the electron is not necessarily a fundamental particle.

At the end of each chapter is found a list of references for further study, and this is bound to be of much value. But, surprisingly enough, we nowhere find a reference to Pauli's article on Wave Mechanics in the *Handbuch der Physik* which and Dirac's book are commonly considered to be the two best expositions of the general principles of quantum mechanics. We also notice "Yukawa" spelt as "Ukawa".

In spite of such imperfections we must confess we have enjoyed reading this book. In the earlier expository part, the author has successfully diagnosed the difficulties of beginners in quantum mechanics, and given full and clear expositions of these topics. The several summaries interspersed here and there in the book are bound to be of value to many students. The examples chosen to illustrate the theory are taken from out of a wide field and serve a very useful purpose. The book is written in a racy style abounding in analogies, and illustrations which serve to make difficult mathematical topics more easily understood.

V. R. T.

CENTENARIES

Webster, Noah (1758–1843)

NOAH WEBSTER, the American lexicographer, was born at West Hartford, 16th October 1758. Having taken his degree at Yale in 1778 and after spending about fifteen years in the legal profession, he found his vocation in the publication of the *American spelling book* of which more than 15,000,000 copies were sold in his life-time. He collaborated with Benjamin Franklin in spelling reform. After trying journalism for about a decade, he found a substantial income by publishing the well-known series of books *Elements of useful knowledge.*

Webster was versatile and covered a vast field of knowledge. His *Brief history of epidemic and pestilential diseases* (2 vols.) (1799) and his *Experiments respecting dew* (1809) were pioneer books in science in America. It is also claimed that Webster's work as statistician and climatologist foreshadowed the census and weather bureaus of later times.

Webster's many-sided publishing activity proved an admirable preparation for lexicography. He worked at his famous dictionary for twenty-five years and brought out the first edition in 2 vols. in 1828 under the title *An American dictionary of the English language.*

Webster died at Amherst, 28th May 1843.

Tweddell, Ralph Hart (1843–1895)

RALPH HART TWEDDELL, a British engineer, was born at South Shields, 25th May 1843. Even during his apprenticeship he took out a patent for a portable hydraulic apparatus to fix the ends of boiler tubes. The success of this led him to employ hydraulic power in boiler construction. In 1865, he invented a hydraulic riveting machine, which reduced the cost to one-seventh of hand-work. In 1871, he invented the portable riveter. This process came to be used all the world over for riveting bridges and ships.

In 1874, Tweddell's system was adopted in French shipbuilding yards. He contributed several papers on the use of hydraulic pressure and earned a gold medal from the Society of Arts. In 1890 he was awarded a Bessemer premium for the paper *Application of water pressure to machine tools and appliances.*

Tweddell died at Meopham Court, 3rd September 1895.

University Library,
Madras, S. R. RANGANATHAN
May 4, 1943.

SCIENCE NOTES AND NEWS

Animal Husbandry Wing Meeting.—The fifth Animal Husbandry Wing Meeting of the Board of Agriculture was held in the last week of November in New Delhi. The main subject discussed was measures to be taken to secure betterment of the large cattle population with a view to increase their produce required for human nutrition. The Conference took the view that by offering the producers increased price and an assured market, it will be possible to secure increased output of milk and ghee. An increase in price can to a certain extent satisfy the demand by drawing upon distant rural areas but considering the fact that a shortage of foodstuffs for cattle exists, possibilities in this direction will be rather limited. The fact that "India suffers from an excess of the animal population" was realised at the meeting and also that elimination of these animals "would confer a real benefit". However in view of the present public sentiments no effective remedy could be found for this major problem.

At the various sub-committees valuable practical suggestions regarding the control of cattle diseases, etc., in India were made. These measures when taken in conjunction with better feeding and breeding programmes, should prove very useful. With a view to make the veterinary education more uniform throughout the country and useful to the cattle industry of the country, a comprehensive curriculum was suggested.

In his opening remarks, the Hon'ble Member for Education, Health and Lands, suggested that the Conference should draw out an objective practical programme of work which may be taken up by the country during the next five years. This appeal has met with the response it deserved. A sixty-point programme has been drawn up and if a concentrated effort is made to put it in practice much good ought to result. One can only wish that this had come five years earlier. It will be too much to hope that this stupendous work can be seriously taken up by the State during the present emergency. It may, however, be considered a charter for post-war reconstruction.

This meeting of animal husbandry workers has given to the country a large amount of data

for the improvement of live-stock. It is hoped that some of these will be put in practice. At any such similar meetings in future, it will be useful if some time was devoted to review the practical results of the last conference. This will give a great impetus to workers in the field.

Mice which take in Cancer with their Mother's Milk.—Researches in recent years into the cause of cancer have clearly shown that a combination of factors is concerned with the initiation of the cancerous process in any one organ. In the case of the cancer of the breast in mice, workers in several countries, but especially in America, have shown the importance of a hereditary factor. By the method of close inbreeding (i.e., by mating brother to sister in each successive generation) it is possible to produce after approximately twenty generations a strain of mice in which all the individuals resemble one another very closely in those characteristics which are capable of being inherited. Pure strains have thus been established varying greatly in the incidence of spontaneous breast cancer. At one extreme are strains in which all the females develop cancer of the breast while at the other extreme are strains in which the disease is completely absent. Cancer of the breast does not occur in males owing to the rudimentary nature of the organ in this sex.

It was expected that by cross-breeding it would be possible to show how the tendency towards cancer of the breast is inherited according to Mendelian laws. But experiment soon showed that when a female of high-cancer strain was mated to a male of a low-cancer strain, the resulting hybrid females developed breast cancer, whereas if a female of low-cancer strain was mated to a male of a high-cancer strain, the resulting hybrid females did not develop cancer. These observations led to the conclusion that some factor other than that contained in the chromosomes must have been transmitted by the high-cancer mother to the offspring, and it was natural to search for this factor either in the placenta, which nourishes the offspring before birth, or in the milk, which nourishes the offspring after birth. The demonstration by J. J. Bittner in America of a cancer-producing substance in the milk of high-breast cancer mice was done in the following way. The offspring of low-cancer parents were removed from their own mothers at birth and were suckled by high-cancer mothers; later in life nearly all of them developed breast cancer. By contrast, when the young of high-cancer parents were transferred to low-cancer mothers, very few of them developed breast cancer, although if suckled normally, nearly all could have been expected to be affected.

The milk factor is highly potent and very stable, for it can exert its effect when the young are suckled by a suitable mother for only a few hours and it can in turn be transmitted by these young to their offspring. Its essential nature is still unknown. Investigations are in progress in this and other countries by which it is hoped to link up the milk factor with the part played by hormones and other substances in the cause of cancer.

(*Monthly Science News*, No. 17, Dec. 1942.)

The Nutrition Foundation.—According to *Science*, 1942, **96**, 490, a group of food and allied manufacturers in America, has contributed a sum of 1,100,000 dollars to support a five-year programme of basic research in the science of nutrition. The Board of Trustees of the Nutrition Foundation has discussed the allocation of these funds for basic research in leading universities throughout the United States. Additional grants-in-aid amounting to 46,000 dollars were appropriated; in all fifty-four grants were made this year to thirty-three colleges, universities and medical centres.

Illustrative of the type of studies being supported by the foundation under the direction of the director, Dr. Charles Glen King, and a distinguished Scientific Advisory Committee, are the following: Isolation of unstable food factors, protein utilization during partial starvation, utilization and distribution of radioactive iron, protection of the teeth afforded by specific nutrients, liver synthesis of blood proteins, nutrition protection against infection, the relation of vitamin A to muscle metabolism, nutritive value of low-cost vegetables, minimum vitamin needs of adults, metabolic balances in diabetes, nutritive protection of the blood vessels and the nutrients in cows' milk under specific conditions.

The programme made possible by the food industry represents the greatest nation-wide contribution to basic research and education that any industry has made in the history of America, according to Dr. King. He believes that the work of the foundation "will mean much in terms of better public health and an improved food supply in the United States and Canada". He pointed out that "significant results to aid in the war effort are already arising from research grants approved this spring".

A World Food and Agricultural Conference.—The United Nations Food and Agricultural Conference, which opens at Hot Sprins, Virginia, on May 18, will discuss the means to satisfy the basic needs of all nations.

The agenda recognises that in the past excessive accumulations of certain agricultural products were, in fact, not surpluses at all when measured by the world's minimum needs of food and clothing and that these so-called surpluses were usually the result of maldistribution and under-consumption.

Finally it examines the conditions which are necessary to assure that what can be produced moves into consumption.

Included in the agenda under the heading food, the Conference will discuss the character and extent of consumption and the deficiencies of each country, the causes and consequences of malnutrition and measures to improve the standards of consumption and reasonable national and international goals for improved food consumption.

Under the heading of other essential agricultural products, discussion will centre round

pre-war consumption level of various countries as influenced by prosperity and international goals for improved consumption with sustained employment and expanded industrial activity.

Dealing with the expansion of production and adaptation to consumption needs, the Conference will study measures for the direction of production toward commodities the supply of which should be increased, measures for the development and conservation of agricultural resources and opportunities for occupational adjustments in agricultural populations.

Some Aspects of Insulation.—This subject for the recent two Cantor Lectures of the Royal Society of Arts (*Jour. Roy. Soc. Arts*, 1943, 91, p. 122) covers two of the most important problems, which have been neglected so far, but which will have to be considered in any post-war planning. They are respectively Heat Insulation and Sound Insulation of buildings.

(1) The importance of thermal insulation has been brought home recently by increasing fuel shortage due to exigencies of the war. In this lecture Mr. Pallot points out the necessity of heat insulation in many industrial undertakings as well as community buildings as a single factor effecting the greatest saving in fuel. He confines his remarks to a temperature range of 100-400° F., thus covering all normal domestic heating requirements and industrial installations using steam at gauge pressures upto about 200 lbs. per sq. inch. Computations based on the theory of heat transmission show that in the case of hot water pipes and Lancashire boilers (8 ft. diam.) as much as 80 per cent. of the fuel-equivalent of heat lost can be saved by efficient insulation. Most of the saving is brought about by the first few layers of insulating materials like asbestos, magnesia, slag wool, etc., which have numerous air-cells to account for their properties. Crumpled aluminium foils held in rigid casing effect a large reduction in the heat lost by radiation. Even aluminium paint will reduce the radiation loss by 50 per cent. Methods of applying such materials and their economic thickness at various temperatures have been given. Attention is also drawn to the problem of heat insulation of buildings and useful data is given of the thermal properties of building materials in terms of their "thermal resistivity" and "thermal transmittance".

(2) The study of sound insulation is a part of the work now being undertaken by the Directorate of Post-War Building of the Ministry of Works and Planning of Great Britain. In this lecture Mr. Allen has referred mainly to noise abatement by planning and by structural techniques. Planning involves use of open spaces as a sound insulator consistent with the density of population and the city area to obtain reasonable conditions of the sound level in an average office room not exceeding 70 dbs. Other means are the use of barriers and height of buildings.

Our knowledge of the behaviour of air-borne and structure-borne sound has progressed enough to evolve structural techniques like suspended ceilings, floating floors and lighter walls and partitions to ensure the necessary degree of quiet by using such materials as quilts, cork, rubber, wall boards and felt. Internal location of the noiser parts to one side in a building is also important. All these can be achieved at a small additional cost but with a large reduction in the noise resulting in a greater degree of comfort and efficiency so as to warrant their widespread use at once.

N. B. BHATT.

Brazil and Indian Jute.—According to the *Chemical and Engineering News* for October 25, 1942, the farmers of the Amazon Valley have tried to cultivate not only ramie but also Indian jute. No practical results were obtained from seeds secured in either Sao Paulo or from Japan. The following year, seeds from India were employed, but the fibre produced did not show the same characteristics as the Indian product. In 1934, some good samples of *Corchorus capsularis* were raised. Since then plantations have been gradually improved and a crop of about 400 tons of fibre is expected this year.

"Juta dos Parintins" is the name given to the jute obtained in the Amazon Valley. Brazilian jute is similar in composition to that from India. The fibres are very uniform and have good tensile strength. With a whitish yellow colour, the fibres contain 71-72 per cent. cellulose, 12-13 per cent. water, and about 0·7 per cent. ash.

Producer Gas Buses for London.—According to the weekly, *The Engineer*, dated February 5, 1943, the London Passenger Transport Board has announced that a scheme for the use of 550 buses equipped with gas producers has been adopted for Central London. The scheme is expected to be put into operation before long. By using anthracite fuel, of which about one ton per week will be needed for each bus, corresponding to a radius of operation of close upon 80 miles before refuelling is required, it is hoped to save 3·5 million gallons of petrol each year. Some of these buses are already said to be in service on east London routes and according to the *Journal*, have given satisfactory operating results. In order to deal with this new scheme of transport operation, a new panel of public service vehicle operators has been set up. Part of the duty of the new panel will be to advise the Ministry of War Transport on the operation of producer gas vehicles on public service routes. Considerable experience has already been gained, both in England and in Scotland, with the operation of public service vehicles on producer gas, but the results of a large fleet of buses operating in Central London should prove of particular interest.

SEISMOLOGICAL NOTES

Among the earthquake shocks recorded by the seismographs in the Colaba Observatory, Bombay, during the month of April 1943, there were three of slight, three of moderate asd two of great intensities. The details for those shocks are given in the following table:—

Date	Intensity of shock	Time of origin I.S.T.	Epicentral distance from Bombay	Co-ordinates of epicentre (tentative)	Depth of focus
		H. M.	(Miles)		(Miles)
1	Great	20 48	2970	..	..
5	Moderate	8 26	1490	Lat. 41°N., Long. 72°.5 E., near Samarkhand.	..
6	Great	22 37	10120	Lat. 33°. 5 S., Long. 73°5 W., near Valparaiso South America.	..
9	Moderate	15 19	4810	Lat. 8°. 5 S., Long. 138° E., near New Guinea.	100
11	Moderate	21 16	4490	..	..
12	Slight	10 44	3190	..	..
13	Slight	02 13	4290	..	..
15	Slight	18 05	10070	..	..

ANNOUNCEMENT

Dr. S. S. Aiyar.—We are glad to announce that Dr. Swaminath Subrahmanya Aiyar, B.A. (Madras), M.Sc., Ph.D. (Wisconsin, U.S.A.), F.I.C., C.R.E.S., formerly for many years Chemical Examiner at the Custom House, Bombay, and recently Chemical Examiner at the Central Revenues Chemical Laboratory, has succeeded Dr. H. B. Dunnicliff, C.I.E., M.A. (Cantab.), Sc.D. (Dublin), F.I.C., I.E.S., as Chief Chemist, Central Revenues Chemical Service.

We wish to offer our heartiest felicitations to him on this occasion. We should like to add that the Central Revenues Chemical Service now has an entirely Indian personnel, the first service in India to have this distinction.

Dr. H. B. Dunnicliff.—We are happy to announce that Dr. H. B. Dunnicliff has been entertained as Director in the Chemicals Directorate of the Directorate-General of Supply. The Government of India deserve praise for their foresight in requisitioning the services of such an experienced scientist and an able administrator for promoting the war effort.

Agra University.—Mr. R. Prasada, M.Sc., Assistant Mycologist in the Scheme of Investigations on Cereal Rusts under the auspices of the Imperial Council of Agricultural Research, has been awarded the D.Sc. degree on a thesis entitled "Morphological and Physiological Studies in Rusts".

We acknowledge with thanks the receipt of the following:—

"Journal of the Royal Society of Arts," Vol. 90, No. 4624; and Vol. 91, Nos. 4627, 4629, 4631 and 4632.

"Journal of Agricultural Research," Vol. 65, No. 11.

"Agricultural Gazette of New South Wales," Vol. 54, Pt. 2.

"Annals of Biochemistry and Experimental Science," Vol. 2, No. 4.

"Journal of the Indian Chemical Society," Vol. 20, No. 2.

"Journal of Chemical Physics," Vol. 10, No. 12; and Vol. 11, Nos. 1 and 2.

"Chemical Products and the Chemical News," Vol. 6, Nos. 3-4.

"Experiment Station Record," Vol. 87, Nos. 5 and 6.

"Transactions of the Faraday Society," Vol. 39, Pt. 1.

"The Review of Applied Mycology," Vol. 22, No. 1.

"Nature," Vol. 150, Nos. 3807, 3813, 3814, 3816, and 3817; and Vol. 151, Nos. 3820, 3821 and 3823.

"American Museum of Natural History," Vol. 51, No. 2.

"Journal of Research of the National Bureau of Standards," Vol. 29, No. 5.

"Canadian Journal of Research," Vol. 20, No. 12.

"Science," Vol. 96, No. 2500; and Vol. 97, Nos. 2505, 2506 and 2508.

"Indian Trade Journal," Vol. 149, Nos. 1921-24.

Books

Radio Receiver Design, Part I.—Radio Frequency Amplification and Detection. By K. R. Sturley. (Chapman and Hall, London), 1943. Pp. xii + 435. Price 28*sh.*

High Frequency Thermionic Tubes. By A. F. Harvey. (Chapman and Hall, London), 1943. Pp. viii + 235. Price 18*sh.*

A Treatise on Physical Chemistry, Vol I.—Atomistics and Thermodynamics. Edited by H. S. Taylor and S. Glasstone. (Macmillan & Co., Ltd., London), 1942. Pp. vii + 679. Price 42*sh.*

Marriage and Family in Mysore. By M. N. Srinivas. (New Book Co., Hornby Road, Bombay), 1942. Pp. 218. Price Rs. 7-8-0.

The Economic Background. By K. T. Shah, P. J. Thomas, J. C. Kumarappa, Sir Datar Singh and Sir Jehangir Coyajee. (Oxford University Press, Madras), 1942. Pp. 64. Price As. 8.

Prism and Lens Making, A Text-Book for Optical Glassworkers. By F. Twyman. (Adam Hilger, Ltd., London), 1942. Pp. iii + 178. Price 15*sh.* Postage 5*d.* extra.

ERRATUM

Vol. 12, p. 119, note entitled "Synthesis of Sulphanilamide Derivatives of Thianthrene", para 2, line 6: The melting point of the diamine *should be* 102° C. and *not* 120° C. as printed.

455-42—Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent, and Published by B. N. Sastri, M Sc., A.I.C., A.I.I.Sc., for the Board of Editors, "Current Science", Bangalore